

Herbaria

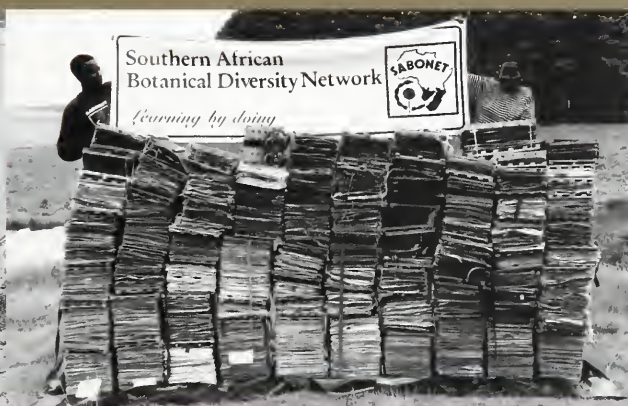
in SABONET countries

building botanical capacity and meeting end-user expectations



by

Tamara J. Smith, Gideon F. Smith & Yolande Steenkamp





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Acronyms and abbreviations

ABGN	African Botanic Garden Network
ANPC	The Australian Network for Plant Conservation
BOZONET	Botanical and Zoological Network for Eastern Africa
B.Sc. (Hons.)	Bachelor of Science (Honours)
B.Tech.	Technical Bachelor degree
BWG	Biosystematics Working Group
CARINET	The Caribbean Network of BioNet-INTERNATIONAL
CBD	Convention on Biological Diversity
CFK	Cape Floral Kingdom
CoP	Conference of Parties
EAFRINET	The East African Network of BioNET-INTERNATIONAL
EASIANET	The East Asian Network of BioNET-INTERNATIONAL
EIA	Environmental Impact Assessment
GEF	Global Environmental Facility
GIS	Global Information Systems
GSPC	Global Strategy for Plant Conservation
GTI	Global Taxonomy Initiative
InetPC	Indonesian Network for Plant Conservation
IUCN	World Conservation Union
IUCN-ROSA	World Conservation Union's Regional Office for Southern Africa
LOOPs	Locally Organised and Operated Partnerships of BioNET-INTERNATIONAL
M.Sc.	Master of Science
NBI	National Botanical Institute, South Africa
NGO	Non-Governmental Organisation
RAMSAR	Convention of Wetlands of International Importance
RDB	Red Data Book
PNE	Planta do Nordeste
PRE	National Herbarium, Pretoria, South Africa
PRECIS	National Herbarium, Pretoria (PRE) Computerised Information System
SABONET	Southern African Botanical Diversity Network
SADC	Southern African Development Community
SAFRINET	Southern African Network of BioNET-INTERNATIONAL
SSC	SABONET Steering Committee
UNDP	United Nations Development Programme
USAID	United States Agency for International Development

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We thank the SABONET national coordinators and the facilitators of the respective workshops in each of the participating SABONET countries for supplying the information that was needed to write this report. We also express our gratitude to the participants of the various workshops for their time and valuable input. Without financial support from the SABONET Project, the workshops would not have been possible.



Participants at the Biosystematics User Workshop in Namibia.

Foreword

Over the past eight years, it has been most enjoyable to observe the development of programs associated with SABONET, and the overall effectiveness of the organisation. Botanists and allied professionals from the ten countries of southern Africa have collaborated to improve their capacities and their ability to provide the kind of information about plants that is of fundamental importance in achieving the goal of sustainable development over this huge area. A knowledge of the plants that occur in the region is fundamental to using them sustainably and conserving them effectively. To be useful, however, that knowledge must be delivered and interpreted in ways that suit the needs of end-users in each country. How can these needs best be met by the trained professionals who live in the country and are among its trusted advisors? SABONET has helped in both of these regards, the development of knowledge and the training of individuals. The maintenance of the contacts that have been established and the network of support that now extends throughout southern Africa will lead surely to many more accomplishments in the future. All of this development must rest on the effective provision of information to the general public, so that all can understand why the proper utilisation and conservation of plants is of importance to everyone.

For the hard-won information about plants to be effectively used, scientists and those working with them must carefully take into account the needs of the end-users, who have diverse needs and expectations for botanical knowledge. In laying out the diverse audiences for botanical information and the many ways in which it must be presented to be truly useful, the present publication will prove to be one of general relevance. The problems considered, however, are by no means restricted to southern Africa. Of particular importance are the ways in which, for example, the efficient curation of collections and libraries is connected with the ability of botanists to provide information properly and in a reasonable period of time. By increasing the general level of understanding, we can increase the chances for survival of a major portion of the more than 20,000 endemic plants species that give this fascinating region its unique character.

Just as SABONET provides an outstanding model for regional south-south collaboration, so the present document is a useful contribution to our understanding of how to make botanical information most readily available and useful to those who need it. As with so many aspects of the overall programme, Brian Huntley and his many colleagues from throughout the region are to be congratulated for their sound, practical, and most useful efforts to expedite the conservation and sustainable use of the plants that, in turn, support us all.

—Prof. Peter H. Raven
Director, Missouri Botanical Garden
Engelmann Professor of Botany, Washington University in St. Louis

Executive summary

In these changing times, when funding is becoming harder to obtain, scientific institutions need to show their relevance to the broader community and be involved in research that generates useful end-products. Furthermore, these institutions need to provide the required services and products at affordable prices. Herbaria are no exception and face numerous challenges.

One of the proposals of the SABONET Mid-term Review was to hold end-user workshops in the ten participating SABONET countries. Altogether 252 participants attended the nine end-user workshops that were held. The idea of these workshops was to bring together end-users of herbarium-generated botanical information from as many fields as possible with the aim of obtaining the following information:

- Who the end-users of botanical information are
- What information they required
- In what format this information was required
- What the end-users' top priorities are

End-users

The end-users were placed in nine different categories:

- Researchers, for example, taxonomists, ecologists, and ethnobotanists
- Government officials and conservation bodies
- Curators, herbarium and museum staff
- Educators from tertiary, secondary, and applied institutions
- Environmental consultants
- Agricultural institutions
- Non-governmental organisations (NGOs)
- Traditional plant users
- Other interested parties

Information

The following list gives an indication of the type of information that the end-users required:

- Access to computerised information and products
- Efficient curation of collections
- Efficient library services and access to relevant literature
- Environmental education
- Expansion of collections
- Field guides and general information
- Improved policies, law enforcement and sustainability
- Plant identifications
- Standardised species lists and updates of name changes
- Suitable infrastructure to house herbarium collections
- Taxonomic and related research
- Training of staff

Formats

End-users required information in both hard copy and electronic formats. However, as computer and Internet facilities are only now becoming more accessible, many of the end-users preferred hard copy format in the form of scientific papers, field guides, pamphlets, and brochures.

Priorities

Although the end-users in the different countries had similar requirements, they prioritised different needs. Some of the countries prioritised the basic needs that resulted in the efficient functioning of herbaria, whereas other countries gave priority to obtaining products that herbaria are expected to produce. Unfortunately, without efficient and effectively functioning herbaria, these products and services cannot be realised.

This report is an overall summary of what is required by the end-users of botanical information in southern Africa, and provides funding bodies with information relevant for decision-making regarding allocation of funds. It also reports on the activities and achievements of the SABONET project since its inception up to the publication of this document.

The Southern African Botanical Diversity Network

The idea of a network aimed at building the capacity of plant scientists and botanical research in southern Africa took shape in 1990. However, funding for such a project was unavailable at the time (Huntley 1997). After numerous meetings to discuss botanical diversity in southern Africa, GEF/UNDP and USAID/ IUCN-ROSA provided funds in 1996 for the development of a project aimed at strengthening botanical research in the region. The Southern African Botanical Diversity Network, or SABONET, has been running for the past nine years (1996–2004) in ten southern African countries: Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe.

The main objective of SABONET was to expand and improve the human resource capacity and the infrastructure of herbaria in southern Africa (Smith & Willis 1997), by developing a strong core of professionals. At the end of the day, these botanists, taxonomists, horticulturists, and plant diversity specialists had to be able to compile inventories, monitor, evaluate, and conserve the botanical diversity of the region in the face of specific development challenges, and to respond to the technical and scientific needs of the Convention on Biological Diversity (CBD).

This has been achieved through training courses, workshops, and collaborative plant collecting expeditions. The project has produced a newsletter, *SABONET News*, published three times a year, and a series of occasional publications in the *SABONET Report Series*. Both publications have contributed to strengthening the SABONET Project and are distributed to between 500 and 1,500 recipients internationally.

The logical framework targets

The SABONET logframe matrix was composed of a table of six targets with a number of activities listed under each of these objectives (Huntley *et al.* 1998, SABONET Steering Committee 2003).

The first target involved training professional southern African plant taxonomists, horticulturists, and plant diversity specialists by means of regional and national training courses, short-term fellowships, and professional exchanges between institutions. The project provided post-graduate and graduate support for students at a number of tertiary institutions.

The second target involved establishing a collaborating Southern African Botanical Diversity Network formally, by appointing a Project Steering Committee, an Executive Committee, establishing a Coordinator's Office, National Working Groups, publishing a newsletter and a Report Series, and organising collaborative field trips to under-collected areas.

The third target was to develop electronic information systems on which data of the region's plant diversity could be stored and accessed. This called for the electronic storage of information on plant specimens, training herbaria and botanical garden staff to use database systems, and purchasing computer hardware and software.

The fourth target was to determine the human resources, botanical expertise, and facilities available within the region.

The fifth target was plant diversity evaluations and monitoring within the region. This included identifying botanical hotspots, centres of plant diversity and endemism, digitised maps, and evaluating the conservation status of vegetation types, biomes, and ecosystems. Other activities included establishing *ex situ* living collections within botanical gardens, identifying under-surveyed areas and taxa, producing checklists of regional and national flora, mapping plant species distributions, and developing a relational database in a GIS-format. This target also included promoting multidisciplinary conservation, for example the end-user workshops, and developing links between herbaria and other institutions responsible for plant conservation.

The sixth target was developing a regional botanical gardens conservation strategy involving a regional survey and needs assessment of botanical gardens, the establishment of working groups, regional workshops and training of staff. It included the development and implementation of threatened plant programmes in botanical gardens in the region and contributed towards the establishment of the African Botanic Garden Network (ABGN).

The Mid-term Review

The original completion date of the SABONET Project was March 2002, but the funding that had originally been provided went further than expected, and the project was extended to Oc-



Computer training.



Herbarium courses.

tober 2004. Mr Jonathan Timberlake (Biodiversity Foundation of Africa, Zimbabwe) and Dr Alan Paton (Royal Botanic Gardens, Kew, United Kingdom) conducted an intensive Mid-term Review early in 2001.

Assessment

They assessed the participating countries in terms of a number of aspects:

- How the improved capacity could be used in plant conservation and sustainable utilisation
- Whether or not the needs of the end-users of botanical information had been met
- The regional benefits of the project
- What the priorities were for the remainder of the project

The reviewers concluded that SABONET had been a very successful and innovative taxonomy project. It had reached many of its goals by building botanical capacity through training, purchasing of equipment, computerisation of collections, and the production of Red Data Lists as well as raising regional awareness of botany.

Concerns

A number of concerns were expressed. These included the following:

- Lack of products produced (specifically practical conservation tools, such as checklists)
- Insufficient attention paid to the end-users of botanical information
- Difference in the sizes and capacities of some of the institutions
- Different mandates of the herbaria in participating countries

There was also concern that the project had not achieved enough regionally and that most participants had viewed it on a national scale.

Recommendations

The reviewers provided some suggestions on the activities of the original SABONET logframe. It was consequently revised, and some of the activities were cancelled: the digitised vegetation maps of major vegetation types, biomes, and ecosystems within the region; the development of a relational database in GIS-format; and the evaluation of the conservation status of vegetation types, ecosystems, and biomes in each country and the region. It was suggested that the remaining time would be better spent strengthening and building on the goals that had already been achieved. A recommendation of the Mid-term Review was that National End-User Workshops be held in each of the ten SABONET countries to form part of the exit strategy of the project. The information from the workshop has been synthesised to form this report. Additional information was obtained from questionnaires sent to the facilitators of the various end-user workshops (Appendix 1).

What has SABONET achieved?

This section briefly summarises some of the achievements of SABONET during the project.

SABONET successfully produced a newsletter that provided an excellent medium to maintain contact between the countries and for other interested parties to gain useful information. Twenty-two issues were published between 1996 and 2003 (*SABONET News* 8(2): 8(1), with a final issue planned for mid-2004.

Occasional publications in the form of a report series were produced (Appendix 2a). These publications were distributed to herbaria, associated libraries, and other interested parties. A number of additional publications in the report series are due before SABONET ends in October 2004 (Appendix 2b).

Training was a very important part of the project and a number of training courses and workshops were held throughout the region: five herbarium management courses, eight plant identification courses, seven data management courses, and four botanical garden workshops. Other courses included a botanical art course, a cycad conservation course, and an Environmental Impact Assessment (EIA) course.

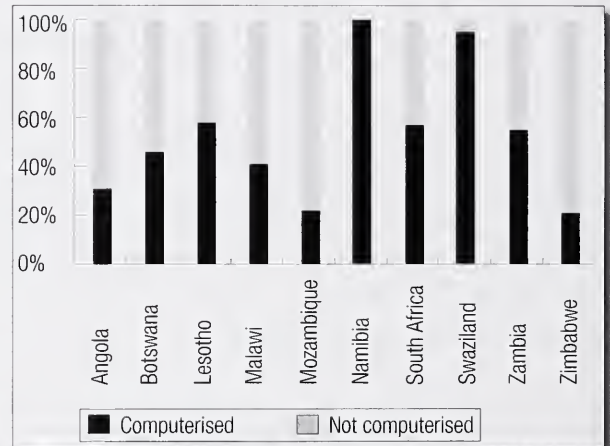


Figure 1. Computerisation of all specimens housed in the participating herbaria within the ten SABONET countries.

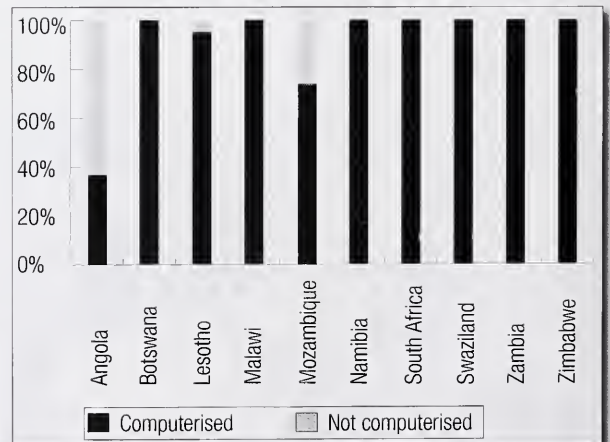


Figure 2. Computerisation of Poaceae specimens housed in the participating herbaria within the ten SABONET countries.

Twenty-six students were sponsored to receive further training at tertiary institutions. Between them, they obtained 14 B.Sc. (Hons.) degrees, 21 M.Sc. degrees, and one Technical Bachelor B.Tech. degree.

Twenty research officers, twenty-one technical assistants, twenty-four data entry clerks, and eight horticulturists were employed in contract positions in the region. Many of these contract workers have subsequently been employed on a permanent basis within their respective organisations. Fifty-two herbarium internships and twenty-three botanical garden internships were completed in the region.

There were two regional collecting expeditions, involving 50 participants from 31 institutions, during which 5,005 specimens were collected. In addition, there were 101 national collecting trips, resulting in the collection of 14,691 specimens. To aid collecting activities, one four-wheel-drive vehicle was purchased for each of the participating countries.

Plant Red Data Lists for nine southern African countries were produced and published as part of the *SABONET Report Series*.

The information was also made available as a searchable database on CD-ROM. Two Threatened Plant Species Workshops were held, and 35 species were identified in the region for *ex situ* conservation in Threatened Plant Programmes.

Computerisation of herbaria is very important and SABONET provided herbaria with the opportunity to use the very efficient database system, PRECIS, National Herbarium, Pretoria (PRE) Computerised Information System. Sixteen herbaria have so far encoded 1,335,761 of the 2,672,872 specimens they contain—a total of 50%. The National Herbarium (WIND) in Namibia was the first herbarium to have all of its *ca* 80,000 specimens computerised (Fig. 1). A special effort was made to computerise all Poaceae specimens—most of the herbaria in the region have successfully encoded all of these (Fig. 2).

A SABONET website exists and e-mail connections are maintained between all participating countries. The ten countries all received computers and printers for the project. The Data Management Section of the National Botanical Institute (NBI) in Pretoria, South Africa, provided maintenance and updates of computer programmes.



Learning how to prepare herbarium specimens.



Plant identification training course.



Collecting specimens during the Regional Expedition to southern Mozambique.



Participants of the Regional Expedition to southern Mozambique.

Herbaria in southern Africa

A herbarium contains collections of preserved plant specimens that provide botanical and plant taxonomic information for reference and research purposes (Steenkamp & Smith 2002). Herbaria form an integral and essential part of botanical research and are important in the fields of systematics, biogeography, and floristic studies. The collections in herbaria represent both historical and current plant resources of a country and, as such, should be considered national assets (Smith *et al.* 1996). In the past, many specimens were lodged in overseas herbaria, resulting in a need to improve herbaria collections within southern Africa (Siebert *et al.* 2001). A number of countries in southern Africa have been through politically volatile times, and many of the herbarium collections have suffered. Both Angola and Mozambique have been through long periods of civil war that have resulted in the transfer of some of the collections for safe keeping.

The functions of herbaria

The functions of herbaria are numerous and varied. They are storehouses of botanical information and most herbaria are involved in documenting the flora of particular regions. They are involved in plant specimen collection and curation, which are necessary for botanical and taxonomic research. They provide plant identification services, which are important in botanical research as well as in industry, agriculture, conservation, education, and forestry. They provide data that can be used to determine or confirm centres of plant endemism and plant diversity, which are important in conservation studies. They supply information that is used for bioregional planning, investigations into rare and endangered species, Red Data List assessments, DNA studies, and bioprospecting.

Herbaria house voucher specimens and are involved in loans and exchanges—for taxonomic studies—between other herbaria. They are involved in the training of future taxonomists and in the education of the public. There are often libraries attached to herbaria that provide recent and historical botanical information. An important function of herbaria is to provide computerised specimen data in the form of up-to-date historical and current names, species lists, localities, geographical distribution maps, and historical information (Bajjnath & Nicholas 1994, Steenkamp & Smith 2002).

Herbaria face numerous challenges and need to demonstrate their

local, national, and regional relevance to have an impact to be able to compete globally for funding. They need to deliver useful, high-quality products and services for a wide range of end-users at affordable prices (Steenkamp & Smith 2002).

The taxonomic information that herbaria generate demonstrates their relevance when we consider that southern Africa contains approximately 30,000 plant species on less than two percent of the earth's land surface. It also contains the whole of one of the planet's floristic kingdoms: the Cape Floral Kingdom (CFK). Four global hotspots lie within southern Africa. These include the Cape Floristic Kingdom, the Succulent Karoo, the Maputaland-Pondoland-Albany Region, and the archipelago-like Afromontane hotspot (Mittermeier *et al.* 1999, Hoffmann *et al.* in prep., Steenkamp *et al.* in prep.).

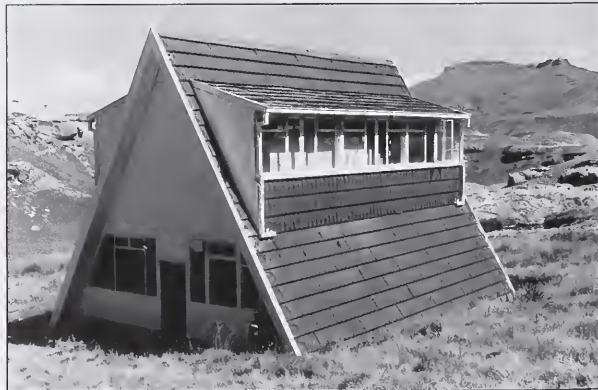
The WWF/IUCN have identified 17 centres of plant diversity in southern Africa. The region also has numerous RAMSAR (Wetlands of International Importance) and World Heritage sites (Smith *et al.* 1999, Steenkamp & Smith 2002). Southern Africa has very high endemism levels with an estimated 70 percent of plant species and infraspecific taxa being endemic (Smith *et al.* 1996). The arid and semi-arid ecosystems of southern Africa contain 46 percent of the world's known succulents (Smith *et al.* 1997). Coastal, marine, and freshwater ecosystems occur, as well as forest and mountain ecosystems (Huntley *et al.* 1998). In addition to their botanical importance, many of these areas are becoming popular eco-tourism destinations. The incredible plant diversity, and its implications for biodiversity issues and conservation planning, indicates the fundamental importance of herbaria within the region.

The needs of herbaria

In 1999, Okafor carried out an assessment on herbaria in Sub-Saharan Africa. He considered 55 institutions, including national herbaria and university herbaria in West Africa, East Africa, and southern Africa. Smith *et al.* (1999) conducted an intensive needs assessment on the southern Africa herbaria involved in the SABONET Project, and the resulting report formed part of the *SABONET Report Series*. Both of these assessments showed similar problems. There is a worldwide lack of funding for herbaria. Without having the necessary funding, herbaria run the risk of being unable to provide sufficient and useful information.



Herbarium, Botswana.



Research Centre and Herbarium, Sehlabathebe National Park, Lesotho.

In order to function efficiently and effectively, herbaria have a number of requirements. They require trained and qualified staff for physical curation, scientific curation, and databasing. Herbaria need to expand continually; and require funding for collecting trips and the provision of sufficient storage space. It is also very important for herbaria collections to be computerised (Smith *et al.* 1999) to allow the integration of information collected over several generations. They need to be associated with libraries that contain relevant literature, both current and historical. These libraries need to be catalogued and computerised with links to search facilities. In order to operate, herbaria need capital for equipment, such as microscopes, herbarium cabinets, and computers.

Categories of herbaria

Herbaria can be classified into different categories depending on their particular functions:

- National and regional herbaria
- Tertiary education herbaria
- Museum herbaria
- Botanical garden herbaria
- Service herbaria
- Conservation herbaria
- Private herbaria

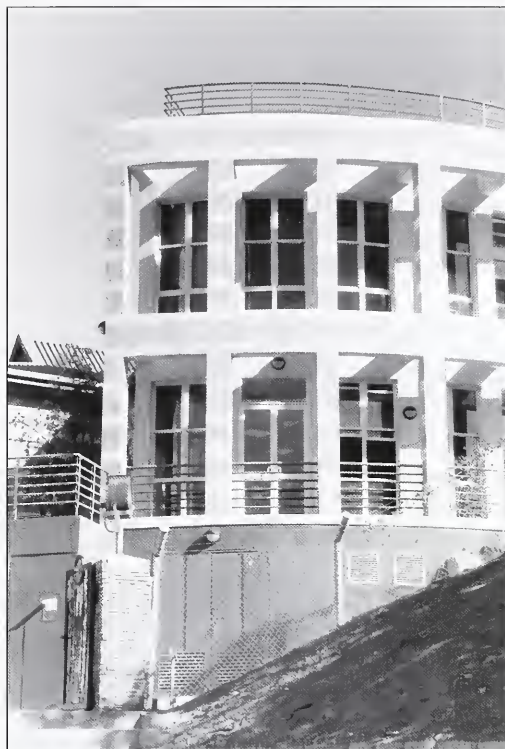
In the region, the largest numbers of specimens are found in national, regional, and tertiary education herbaria (Fig. 3). Not all of the participating SABONET countries have herbaria falling into all of the categories. South Africa has the largest number of herbaria (72) with 3,110,387 specimens in total (Fig. 4) and is the only country that has representatives in all of the herbarium categories. The top ten herbaria in southern Africa, ranked according to the number of specimens housed, are provided in Table 1. A complete list of all southern African herbaria and their acronyms is provided in Appendix 3.

National and regional herbaria

The primary role of national and regional herbaria is to provide reference collections of the flora in the country or region. Some of the collections do, however, include specimens from other countries or areas. These herbaria are often involved in other functions, such as research and providing plant identification services. National herbaria are found in Botswana, Malawi, Namibia, Swaziland, and Zimbabwe. Botswana and South Africa also have regional herbaria.

Herbaria associated with tertiary institutions

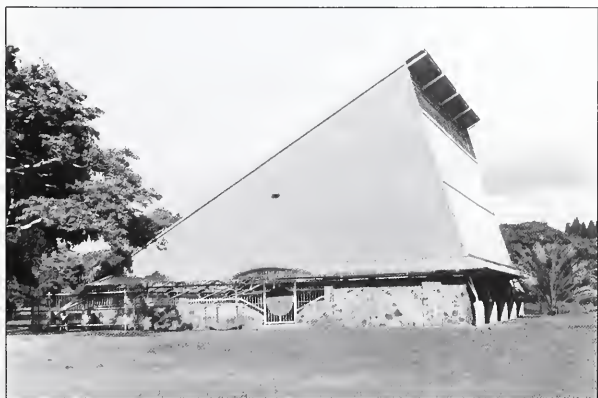
Tertiary institutions include universities, technikons, and agricultural colleges. The principal function of these herbaria is to be a teaching tool, providing training to students in the fields of botany, taxonomy, systematics, nature conservation, forestry, and agriculture. Some of these herbaria are involved in research and offer the community identification and education services. The scientific staff members at most of these herbaria are involved in teaching and research, and the curation of herbarium collections form part of their duties. In southern Africa, herbaria associated with tertiary education institutions are found in Angola, Botswana, Lesotho, Mozambique, South Africa, and Zambia.



National Herbarium, Windhoek, Namibia.



Building housing Herbarium, Chelinda, Nyika National Park, Malawi.



Desert House, National Botanical Garden, Harare, Zimbabwe.

Museum herbaria

The main function of museum herbaria is to hold reference collections. Some of these herbaria are involved in plant identification, student training, and education of the public. South Africa and Zimbabwe are the only two southern African countries that have herbaria in this category. There are four museum herbaria in South Africa and two in Zimbabwe.

Herbaria associated with botanical gardens

The main function of these herbaria is to provide reference collections for plant identification. Although there are a number of botanical gardens within southern Africa, South Africa is the only country that has herbaria associated with botanical gardens. This excludes the herbaria that fall under the category of national and

regional herbaria and are associated with botanical gardens, for example in Malawi and Zimbabwe.

Conservation herbaria

These are field herbaria associated with a particular nature reserve and generally contain collections and information of the flora found within that reserve. They are used as a reference collection, occasionally for research purposes, for development of management practices within the reserves, and as education facilities for the public. Generally, staff members associated with these herbaria are not employed solely as curators, so herbarium management is merely one of their duties. There are twenty-three herbaria associated with reserves and national parks in South Africa, one in Lesotho, and one in Zambia.

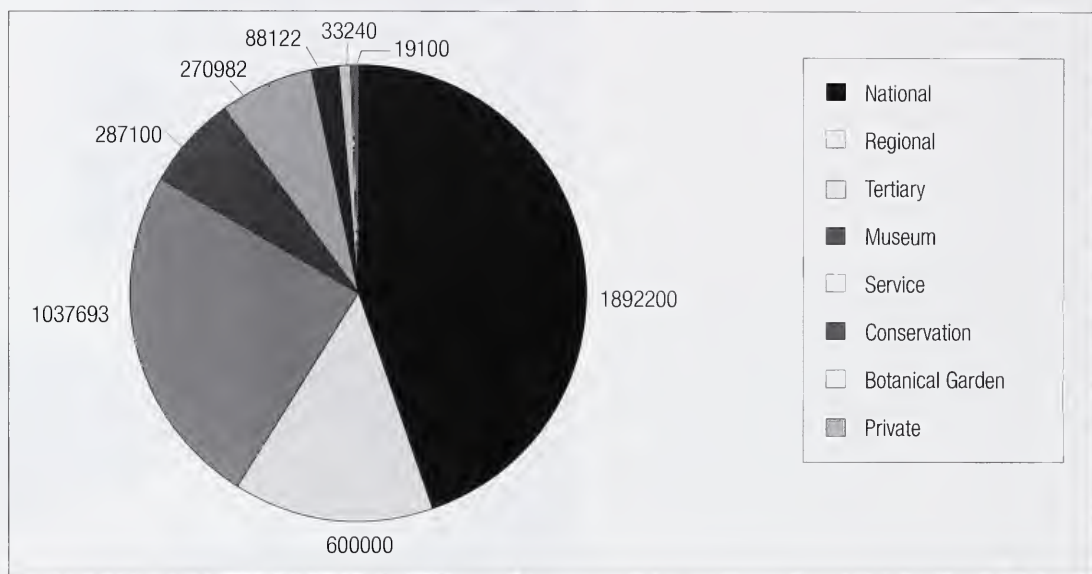


Figure 3. Number of specimens found in the different categories of herbaria in southern Africa.

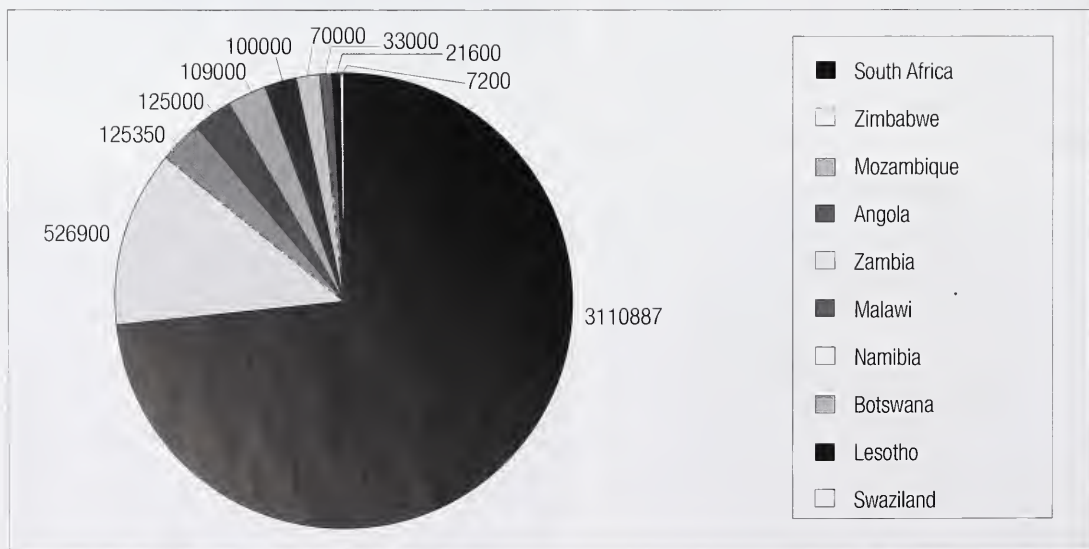


Figure 4. Number of specimens housed in the participating herbaria in the ten SABONET countries. (Compiled from Smith & Willis 1999.)

Service herbaria associated with other government departments

These herbaria act as reference collections for plant identification, to help develop management strategies for conservation, forestry, and farming practices. Herbaria falling into this category are found in Botswana, Lesotho, South Africa, Zambia, and Zimbabwe.

Private herbaria

Private herbaria function as reference collections for the flora found on private reserves or farms. South Africa has three private herbaria.

Table 1. The largest herbaria in southern Africa, according to the number of specimens housed.

Herbarium	Acronym	No. of specimens
National Herbarium, National Botanical Institute, Pretoria, South Africa	PRE	1,200,000
Compton Herbarium, National Botanical Institute, Cape Town, South Africa	NBG	500,000
National Herbarium and Botanic Gardens, Harare, Zimbabwe	SRGH	500,000
Bolus Herbarium, Botany Department, University of Cape Town, South Africa	BOL	300,000
Selmar Schönland Herbarium, Albany Museum, Grahamstown, South Africa	GRA	200,000
Bews Herbarium, School of Zoology and Botany, University of KwaZulu-Natal, South Africa	NU	120,000
Charles E. Moss Herbarium, Botany Department, University of Witwatersrand, Johannesburg, South Africa	J	100,000
National Herbarium and Botanic Gardens of Malawi, Zomba, Malawi	MAL	100,000
Natal Herbarium, National Botanical Institute, Durban, South Africa	NH	100,000
H.G.W.J. Schweickerdt Herbarium, Department of Botany, University of Pretoria, South Africa	PRU	100,000

Plant taxonomy in southern Africa

Taxonomy is the science of discovering, identifying, classifying, and naming organisms, their lifecycles, ecological roles, functions, and relationships. Plant taxonomy is the basis for any botanical study and a number of fields rely on plant taxonomists for their knowledge. However, the importance of taxonomy has been neglected and under-funded in many parts of the world. Very few of the more technical and readily funded aspects of botany can be performed without fundamental taxonomic studies (Akeroyd 1997, Mattson 1999, Smith & Wolfson 2004).

Taxonomy is the tool with which the biodiversity of living organisms can be recorded. Considering that plant diversity in southern Africa is very high, the number of taxonomic staff employed is incredibly low. With increasing attention being given to biodiversity conservation and bioregional planning, plant taxonomists have a crucial role to play in the inventory of plant diversity in the region.

Plant taxonomic expertise in southern Africa

In the past, much of the taxonomic knowledge and expertise within southern Africa was lost because, although there were many foreign taxonomists working on southern African taxa, they almost invariably took their knowledge, skills, and plant collections back to their countries of residence. Another problem is that, because of the lack of younger taxonomists entering the system, much of the existing expertise is not being passed on when older taxonomists retire. On the other hand, taxonomic expertise in southern Africa has been greatly improved by the SABONET project in the form of funding for students, training for staff, and employment of additional contract staff.

In 1997, SABONET started a project aimed at obtaining an inventory of both local and international plant taxonomists working on southern African flora (Mössmer & Willis 2000). This publication contains a directory of experts and lists their fields of expertise and geographical areas of interest, the major plant groups,

families, genera on which they work and their contact details. It includes a selected list of publications by each of the experts, listed by author and by taxon. The resulting database contained data on 202 experts and covered 225 plant families and 1,300 genera (Mössmer & Willis 2000). The information from this survey was published as part of the *SABONET Report Series*. Within southern Africa the greatest concentration of botanical taxonomic expertise is found in South Africa followed by Zimbabwe, Namibia, and Malawi (Fig. 5).

Needs of taxonomists

According to information obtained at a symposium in 1996 in South Africa entitled "Priorities in Plant Systematics Research in southern Africa," taxonomists have nine priorities (Smith *et al.* 1996):

- The networking of southern African herbaria
- Coordinated plant collecting programmes for under-collected areas
- Indicating the conservation status in monographs and floras, and on specimens
- Standard use of data on plant species distributions
- Capacity-building in plant systematics
- Studies on phylogenetic and species-level diversity
- Regional directories of botanical information, specialist taxonomists, and checklists
- International liaison and involvement
- Promotion and marketing of plant systematics

These needs were determined in 1996; since the inception of the SABONET Project, many of these taxonomic goals have been attained, for example, the networking of southern African herbaria, and capacity-building in plant systematics through SA-BONET. As SABONET draws to a close, it is essential that these priorities be continually assessed to ensure that the processes that have been put into place are not neglected.



Figure 5. Taxonomic expertise in southern Africa. (Compiled from Mössmer & Willis 2000.)

Role of taxonomists in plant conservation and sustainable plant use

All of the southern African countries involved in the SABONET Project have entered into various biodiversity agreements, such as the Global Strategy for Plant Conservation (GSPC), which falls under the Convention of Biodiversity (CBD). It is the plant taxonomists who are best equipped to inventory plant diversity, thus providing the decision-makers with relevant information, enabling them to make informed decisions on biodiversity issues and conservation planning. The dedicated nature of taxonomists and their love for what they do together with their knowledge gained after many hours of intensive fieldwork makes them one of the primary sources for reliable information on the threatened status of species.

Systems, like the Red Data List, need to be put into place to monitor biodiversity and therefore minimise the loss of species. Red Data Lists are essential tools when it comes to conservation planning and environmental impact assessments. Taxonomists are involved in generating new, or refining and updating existing Red Data Book (RDB) information. Herbaria provide the relevant information, through collections and Floras, needed to compile these lists and are therefore very important in threatened plant conservation (Golding 2001).

Image of herbaria and taxonomists

Herbaria and taxonomists need to cultivate a new image in the scientific, as well as the entire intellectual community. The only people who can bring this about are the taxonomists themselves, together with their managers and administrators. Very often, one of the crucial roles of herbarium managers is to change the per-

ceived image of taxonomists. In order to do this, herbarium managers need to find out several things, namely:

- Do herbarium staff have a vision?
- Are appropriate strategies in place to ensure the achievement of the vision?
- Are there structures in place that will help to achieve these strategies?
- Does a business plan exist?
- Do managers subject themselves to the same rigorous criteria according to which they assess their staff?

It is important to determine whether the leaders are equipped to deal with project, financial, and event management competently. The leaders of herbaria need to stay informed of developments and ensure that good corporate governance is upheld. They must know what their goals are and how they intend to achieve them. They must be confident that the methods employed in the process will stand up to global scrutiny and peer review, which is an important principle of the New Partnership for Africa Development (NEPAD) (Klopper *et al.* 2002). While this might sound more business-orientated than scientific, it is what is required. It is up to research management to take full responsibility for their staff and the products they generate.

The following aspects will also assist the leaders of taxonomic projects to respond effectively to the challenges ahead:

- Invest in strengthening leadership capabilities
- Establish partnerships with experienced, like-minded individuals and organisations
- Learning by doing, which is the motto of SABONET
- Communicate best-practice to colleagues
- Apply sound business principles to management



Participants at a SABONET regional plant identification training course.

The role of botanical gardens

Plant species and their habitats are threatened globally. Botanical gardens provide refugia where many of these threatened species can grow and survive *ex situ*. These gardens are actively involved in conserving plant diversity and in the sustainable use of plant resources. Botanical gardens also play a very important role in raising public awareness on the issues of plant diversity and conservation.

One of the targets of the initial SABONET logframe was the development of a regional botanical gardens conservation strategy. Apart from establishing this strategy and an action plan for southern African gardens, one of the activities was a regional survey of the botanical gardens. The result was a needs assessment survey of

20 southern African botanical gardens (Table 2). This assessment was conducted with the aim of determining their needs within the region. The results were published as part of the *SABONET Report Series* (Botha *et al.* 2000).

Although many of the gardens are situated close to herbaria and botanical libraries, the information in these libraries is not always relevant to botanical garden staff. It is also difficult for them to conduct research if they are not close to the facilities provided by herbaria and libraries. Botanical gardens use the information in herbaria for reference and education purposes (Botha *et al.* 2000). Many of the problems of botanical gardens are similar to those of herbaria and include insufficient staff and lack of training. There is also a need for the computerisation of garden collections and up-to-date inventories of plants in the gardens.

Table 2. Botanical gardens surveyed in the ten participating SABONET countries.

Country	Town	Botanical garden
Botswana	Gaborone	National Botanic Garden
Lesotho	Katse Dam	Katse Botanical Garden
Malawi	Lilongwe Mzuzu Zomba	Lilongwe National Botanic Garden Mzuzu National Botanic Garden Zomba National Botanic Garden
Mozambique	Maputo Maputo Maputo	INIA Botanical Garden Tunduru Botanical Garden University Botanical Garden
Namibia	Windhoek	National Botanic Garden
South Africa	Durban Bloemfontein Betty's Bay Worcester Cape Town Nelspruit Pietermaritzburg Pretoria Roodepoort	Durban Botanic Gardens Free State National Botanical Garden Harold Porter National Botanical Garden Karoo Desert National Botanical Garden Kirstenbosch National Botanical Garden Lowveld National Botanical Garden Natal National Botanical Garden Pretoria National Botanical Garden Walter Sisulu National Botanical Garden
Zambia	Chilanga	Munda Wanga Trust Botanical Garden
Zimbabwe	Harare	National Botanic Garden

The end-users of botanical information

Scientific institutes need to show their relevance and be involved in applied research in order to obtain the funding that they need to operate. Botanical gardens and herbaria are no exception. Botanical gardens are able to show their relevance through education and awareness of conservation issues, sustainable plant use, and *ex situ* conservation programmes. Herbaria need to be able to provide tangible products and services to a range of end-users to prove their relevance. To do this effectively and efficiently, herbaria need to critically identify the possible end-users of botanical information and determine their information requirements.

The following sections of this publication consider who the end-users of botanical information are, what type of information they require, in what format it is required, and the top priorities of the end-users within the ten participating SABONET countries. At many of the national end-user workshops the participants divided up into breakaway groups to discuss the needs of the end-users.

In Namibia there were four groups, namely the (i) producers of taxonomic information, which included taxonomists from the herbarium and the museum; and the (ii) primary consumers or researchers who use taxonomic information to produce secondary biosystematic products. The remaining two groups were combined during the discussions and included (iii) secondary consumers, for example EIA consultants, who use taxonomic information but do not produce biosystematic products, and (iv) tertiary consumers, for example educators and the public, who use general biosystematic information (Irish 2003). The discussion groups in the majority of the other countries were randomly chosen and, owing to lower numbers, the end-users did not remain in their respective end-user categories. Using breakaway groups was a very effective way of discussing the needs of end-users as it allowed participants with similar needs to compare and discuss their requirements in smaller groups.

The time spent in these breakaway groups varied at each of the workshops. At the Angolan, Namibian, and South African workshops the participants spent the greater part of the workshop in these groups. At the Botswana and Mozambique workshops, half

the time was spent discussing end-user needs in breakaway groups. At the Lesotho workshop the participants only spent a quarter of the time in these groups. The workshops held in Swaziland, Zambia, and Zimbabwe followed a different format and no discussion sessions were held (Fig. 6).

Who are the end-users of botanical information?

The potential end-users of botanical information come from many disciplines. Some of them are obvious users of botanical information and use herbarium services regularly, for example, conservation bodies and environmental consultants, while others are less frequent users of botanical information. For an extensive list of the potential end-users of botanical information, see Appendix 4. For the purposes of this report, the end-users represented at the workshops were divided into 19 categories. Although some of the participants could be placed in more than one category, for the purpose of analysis, each participant was assigned to only one end-user category.

The number of participants at each national end-user workshop varied (Fig. 7). The end-user workshop in Namibia was a joint workshop with SABONET and the Biosystematics Working Group (BWG) and included end-users of both botanical and zoological information, which resulted in the higher numbers of participants. The majority of the participants at this workshop were providers of taxonomic information from the National Botanical Research Institute, Namibia, and the National Museum of Namibia. Other participants included individuals from government departments, tertiary institutions, agricultural institutes, international NGOs, and environmental consultants.

The widest range of end-users attending the national end-user workshops was found at the Angolan, South African, and Mozambican workshops. These workshops had representatives from fourteen (Angola and South Africa) and thirteen (Mozambique) end-user groups. Swaziland and Zimbabwe had the smallest range of end-users attending the workshop (Table 3).

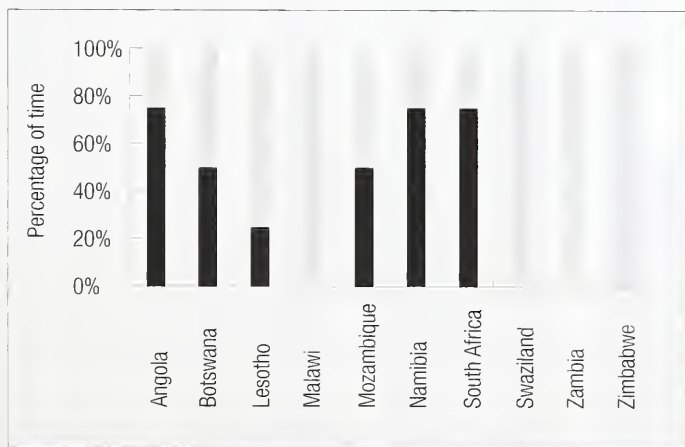


Figure 6. Percentage of time spent in break-away discussion groups at the end-user workshops. The black bars represent the amount of time spent in discussion groups.



Plant identification training course.

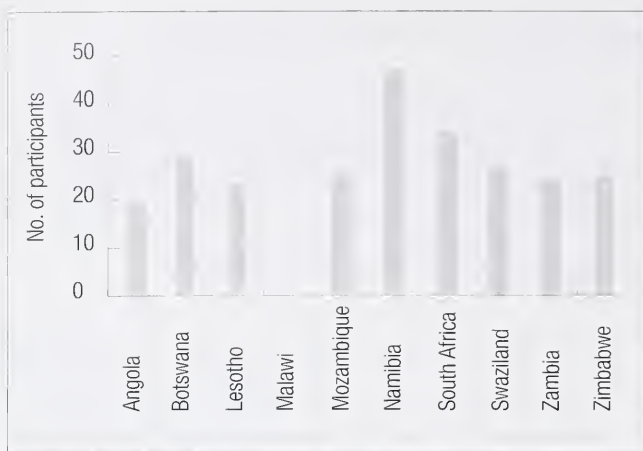


Figure 7. Number of participants attending the end-user workshops in the participating SABONET countries.



Aquatic plants identification training in Botswana.

Table 3. The number of participants represented in the 19 different end-user categories in each country.

	Angola	Botswana	Lesotho	Mozambique	Namibia	South Africa	Swaziland	Zambia	Zimbabwe	Total
Agricultural institutions/farmers	2	0	1	0	6	3	3	1	0	16
Applied educators (training centres)	0	3	0	1	0	0	0	0	22	26
Botanic gardens/museum	1	4	1	3	6	2	0	1	0	18
Botanical organisation/amateurs	1	2	0	1	1	1	0	1	0	7
Ecologists	1	1	0	2	2	2	3	0	0	11
Eco-tourism	0	0	0	1	0	0	0	0	0	1
Environmental consultants	1	1	0	0	3	2	0	0	0	7
Ethnobotanists	1	0	0	2	0	1	0	0	0	4
Government (conservation bodies)	1	0	5	0	1	3	0	0	0	10
Government (ministry)	1	6	7	2	4	1	3	1	1	26
Herbarium staff	1	5	2	2	10	2	2	1	0	25
International NGOs	1	1	1	2	3	0	1	1	0	10
National NGOs	0	0	2	1	0	0	4	1	0	8
Other - environmental lawyer/media	0	0	0	0	0	1	0	4	0	5
Other scientists	2	3	0	0	3	5	0	0	0	13
Secondary educators (school)	1	0	0	0	0	0	0	0	1	2
Taxonomists	4	2	1	4	4	4	4	0	0	23
Tertiary educators (university)	1	1	2	3	4	6	6	12	1	36
Traditional plant users	0	0	1	1	0	1	0	1	0	4
Total number of participants	19	29	23	25	47	34	26	24	25	252

In Zimbabwe, most of the participants attending the workshop were educators from agricultural training colleges, teacher training colleges, and universities. The management of the National Herbarium and Botanic Gardens in Zimbabwe decided that one workshop would not give a good representation of the end-users and it would be better to run different end-user workshops for the different categories of users. Two of these workshops were held; therefore, the information that was obtained is biased towards a single end-user category. In Zambia, presentations on genetic plant resources and traditional health practices resulted in most of the information obtained at the workshop revolving around the requirements for these two groups. No breakaway discussion sessions were held at the workshop and this, together with the length of the workshop (one morning), meant that little time was available for discussion.

Overall, 252 end-users attended the nine workshops. The highest numbers of end-users attending the workshops were in the following categories:

- Tertiary educators—36
- Government officials—26
- Applied educators—26
- Herbarium staff—25
- Taxonomists—23

The high number of applied educators is attributable to the nature of the Zimbabwean end-user workshop. All of the end-user categories recommended in the Mid-term Review were represented in at least one country. An additional category, eco-tourism, was included in this list; however, this category was represented only at the Mozambican workshops. An environmental lawyer was present at the South African workshop. In Zambia, four media representatives were present. The range of end-users attending the workshops indicated that the information obtained and discussed was representative of the needs of the majority of end-users of botanical information and herbaria in the region.

What information do end-users require?

The requirements of end-users of botanical information differ in the participating countries. Appendix 5 provides a comprehensive list of all end-user needs that were discussed at the various workshops. The differences between the needs of taxonomists and other end-users of botanical information were clearly seen at the Namibian workshop. In this workshop the delegates were divided into those participants who were producers of taxonomic information (taxonomists) and those who were users of taxonomic information. The producers were concerned with infrastructure, curation of the collection, staff training, and defining government policies. Improvement in all these areas would result in the efficient running of herbaria and more effective production of information for other end-users. As a result, if taxonomic priorities were met, many of the end-user priorities would also be met.

The end-user requirements have been divided into 12 main categories. Appendices 6a, 6b, and 6c provide summaries of the data used in the following points.

1. Standardised species lists and updates of name changes

Species lists, checklists, and inventories should form the basis for most of the information that is produced by herbaria. Without this type of information, many of the end-user requirements cannot

be met. Most of the participating countries indicated the importance of this requirement, but only four—Botswana, Mozambique, Namibia, and South Africa—gave it a high priority.

In South Africa, it was suggested that the species lists should be updated annually in hard copy and should be updated continually and made available in electronic format on the Internet.

These two needs can only be achieved if funding is available, the required technology is functional, and regions have been adequately sampled to ensure that herbaria are well stocked and representative of the region. Suitable library facilities, equipment, and trained staff are also required (Steenkamp & Smith 2002).

2. Plant identifications

Plant identification is one of the best-known functions of herbaria. End-users in most of the countries recognised the importance of this activity. Most of them acknowledged that a fee should be charged for identifications and that this generally did not prevent end-users from using herbaria. Participants in Botswana and South Africa indicated that charging a fee could prevent end-users from using herbaria. South Africa suggested a change in the structure of fees so that the greater the number of specimens identified for a single end-user, the lower the fee per identification.

It was agreed that in most countries the length of time that it took to get information back from herbaria was a problem and could prevent end-users from using these facilities. Some people were concerned about the quality of specimens that herbaria required. The South African end-users suggested that a sliding scale be used so that the fees were higher for poor quality specimens and lower for better quality specimens.

To improve this service, additional trained staff members should be employed and herbaria should be adequately stocked and representative of the flora of the region (Steenkamp & Smith 2002).

3. Efficient library services and access to relevant literature

In order to function effectively, herbaria need libraries that provide access to current and historical literature. The majority of the end-users were aware of this. South Africa suggested that new literature be made available on the Web and that herbarium libraries put older literature onto CD-ROM or onto the Web for easy access.



Plant identification in the field.

This requires a number of things, including an increase in library staff and the procurement of computers and scanning equipment. Internet access is needed, library holdings must be accessioned and accessible, and a comprehensive journal subscription must be made available (Steenkamp & Smith 2002).

4. Expansion of collections

Many of the functions of herbaria, for example, plant identifications and the production of species lists, can only be achieved if there are suitable reference collections within the herbaria. It is imperative that collecting trips be conducted on a continual basis. South Africa and Swaziland saw collecting and expansion of herbarium collections as being very important, while other countries, for example Namibia, placed this need much further down the list.

South Africa suggested that the National Botanical Institute (NBI) be responsible for organising and coordinating field trips to help improve collections in all South African herbaria. They suggested that amateur botanists and conservators should be trained in correct and ethical plant collecting practices and that collection permits needed to be more easily accessible. It was also suggested that an annual meeting be held to determine the progress of collecting trips in the country.

To achieve this, more staff is needed to process the specimens, more floor space, cabinets, additional collecting equipment, and sufficiently maintained vehicles for fieldwork are required (Steenkamp & Smith 2002).

5. Effective curation of collections

Effective curation is needed for the smooth and efficient running of herbaria and without this, some of the other end-user needs, for example plant identifications, could not be met. South Africa suggested that a herbarium management system be developed to assist with the manner in which herbaria function. They suggested that this system should include an accession register, determination lists, checklists, lists of names, cupboard lists, lists for permit-granting bodies, as well as loan lists.

A taxonomic database for herbarium staff should also be available including names, distributions, images, photographs, line drawings, and literature references. There is a mini PRECIS system currently available, but it is limited to archival, cataloguing, and labelling functions. While taxonomists in Namibia considered

curation to be a top priority, this was not the case for the other end-users in the country.

Efficient functioning of a herbarium management system would require adequate computer hardware and additional programme and software developers (Steenkamp & Smith 2002).

6. Computerised information and products

End-users in some of the countries, for example South Africa, expressed the need for a web-based or electronic (CD-ROM) integrated botanical information system. It was suggested that this system should include a literature database (journal details), and a practical, easy-to-use "Quick Identification Guide" based on species lists, with digital images, scientific names, synonyms, distribution data, specimen images (type and representative) and some literature on the taxa.

The NBI agreed that this was probably the most important end-user need, but the costs of such a project are very high as it requires intensive taxonomic research to generate the information that is required. Funds for this type of research and for suitably trained taxonomists to complete the task within a reasonable time are scarce. There is no infrastructure present to run such a system, while additional IT personnel, as well as highly trained herbarium and data capture staff, are needed. Other requirements include equipment to scan specimens, digital images of all taxa, adequate sampling, existence of research projects, and adequate library information (Steenkamp & Smith 2002).

In Namibia, the end-users recommended a similar system, which they called a "one-stop-shop". This would provide a way of communicating information to the end-users, for example, on permits and regulations for collecting of material, collecting techniques, herbarium standards, and information on under- and over-collected areas or groups. The taxonomists expressed their concern about the quality of specimens collected by non-taxonomists (Irish 2002).

In Swaziland, the end-users suggested that an electronic identification service would be a useful tool.

7. Suitable infrastructure to house herbarium collections

In Namibia, taxonomists saw the lack of infrastructure, the scarcity of buildings and the expense of their maintenance, as well as insufficient floor and cabinet space, as serious problems. This was less of an issue for the other end-users in that country. Unfortunately, without these basic facilities, taxonomists are unable to provide end-users with the information that they require. The end-users in Mozambique suggested that smaller herbaria should be established in the country, especially in the central and northern regions. In Lesotho, it was suggested that one of the three herbaria in the country be upgraded to the status of a national herbarium.

8. Field guides and general information

Many of the end-users indicated that popular literature in the form of guidebooks and the production of lists of species lists with common and local names was the responsibility of herbaria. In Namibia, taxonomists stated that this was outside their field of expertise. They said that, although they were prepared to provide



Preparing herbarium specimens in the field.

the information, scientific writers and linguists (for local names) should do the production of publications (Irish 2003).

Unfortunately, there is usually insufficient institutional funding available for these types of products.

9. Taxonomic and related research

The majority of end-users considered taxonomic research and the resulting scientific publications as being important. In Namibia, only taxonomists saw this as an important requirement. No taxonomic publications are being produced locally in Namibia. Instead, foreigners are describing most of the Namibian taxa, although usually with the co-operation of Namibian institutions. This raises doubts over long-term sustainability, and it was suggested that if the amount of time taxonomists spent on administration duties was reduced, more time could be spent on writing and preparing manuscripts for publication (Irish 2003).

All of the countries indicated that having accessible research facilities and current information encouraged end-users to use herbaria. Related issues that included research on endemism, habitat requirements, life histories, indicator species, medicinal plants, and alien species, were also considered important. Other needs included information on plant distribution and vegetation maps.

End-user requirements included determination of plant conservation status, the production of Red Data Lists, biodiversity research, and plant propagation information. In Namibia, taxonomists feel that they cannot undertake many of these aspects of research because of financial and time constraints. They suggested that researchers from other disciplines should be responsible for much of this type of research. In most cases they would be prepared to provide the relevant information and to co-operate with public relations exercises (Irish 2002).

10. Environmental education

The end-users of Angola, Botswana, Lesotho, and Swaziland indicated the need for outreach programmes to raise public awareness of herbaria and their functions.

The end-users in Botswana suggested that adequate signage in the herbaria and gardens, as well as a help desk providing botanical information was necessary. In Lesotho, many of the participants were unaware of herbaria, their roles, and the existence of SABONET. At the Namibian workshops, a large number of end-users were unaware of the products that the various biosystematic institutions offered. This suggests that there is a problem with marketing the existing products of herbaria.

11. Staff training

To meet many of the above-mentioned needs of end-users, suitably trained staff members are necessary. Without suitably trained staff, many of the end-user needs cannot be met. Surprisingly, only end-users in Mozambique, Namibia, and South Africa saw the training of staff as a top priority. The SABONET project has helped alleviate the problem of staff shortages to some extent, but in order to provide the services and products required by end-users, herbaria throughout southern Africa need more staff members.

Ironically, owing to the SABONET project, the higher qualifications obtained by herbarium and botanical garden staff resulted in better-paid positions in other organisations. This led to much of the knowledge being lost. Still, many of the SABONET contract staff have been given permanent positions in their respective herbaria. This has been difficult to achieve in Lesotho, because of a lack of funds and there is concern that much of the expertise developed during the SABONET Project will be lost.

Another problem is the lack of young taxonomists, and the rapid loss of expertise as older taxonomists retire and take their knowledge with them. Most training of taxonomists is done *ad hoc* and "in-house". It is evident that more of the initial primary training be carried out at tertiary institutions and that herbaria provide additional training and guidance to young taxonomists. The end-users in Namibia suggested that the tertiary institutions and the biosystematic institutions work together to improve the training of taxonomists.

End-users also required training for data-capturers, para-taxonomists, and traditional healers. In South Africa, it was suggested that this need could be addressed by conducting courses at the NBI for various end-user groups.

12. Improved policies, law enforcement, and sustainability

Namibian taxonomists expressed concern over government policies. They suggested that if all biosystematic institutions were consolidated and operated from the same building, this would help to streamline processes involving permits, loans, and transfers. Swaziland suggested that stronger enforcement of flora laws was needed. In Lesotho, some participants were concerned over the state of the environmental report and that the government would not be able to sustain the SABONET Project.

Taxonomists in Namibia thought that the majority of the funding for services should come from the end-users themselves, while the other end-users thought that the Minister of Finance should provide the majority of the funding for biosystematics in the country. However, they were prepared to contribute towards this funding. (Irish 2003).

In what format is the information required?

The format in which the information is required by the end-users tends to differ among countries rather than among the end-us-



Inside a herbarium.

Table 4. End-user priorities in the participating SABONET countries. No information on the top priorities of end-users was supplied for Malawi, Zambia, and Zimbabwe.

Angola	Botswana	Lesotho
<ol style="list-style-type: none"> 1. Plant identification 2. Plant conservation status 3. Medicinal plants 4. Vegetation mapping 5. Guided visits (high schools) 6. Information on Red Data Lists 7. Information on endemic plants 	<ol style="list-style-type: none"> 1. Plant identification 2. Inventories (checklists) 3. Information service centre / help desk 4. Outreach Programmes 5. Library 6. Plant conservation status 7. Plant propagation methods 8. Plant use (toxicity, invasiveness) 9. Signage 10. Format of information 	<ol style="list-style-type: none"> 1. Awareness 2. Determining different end-users 3. Plant propagation 4. Information on Internet 5. Information for Environmental Impact Assessments 6. Information on Red Data Lists
Namibia	Mozambique	South Africa
<ol style="list-style-type: none"> 1. Institutional structure 2. Training for herbarium staff 3. Collection maintenance 4. Databases and information technology 5. Library 	<ol style="list-style-type: none"> 1. Species lists 2. Training for herbarium staff 3. Plant distributions 4. Database systems 5. Develop smaller herbaria 6. Expansion of collections 7. Library 8. Information on Red Data Lists 	<ol style="list-style-type: none"> 1. Up-to-date name lists 2. Standardised species lists 3. Integrated Botanical Information System 4. Expansion of collections 5. Plant identification 6. Library 7. Training of taxonomists 8. Training of data-capturers 9. General training 10. Herbarium Management System
Swaziland		
<ol style="list-style-type: none"> 1. Expansion of collections 2. Electronic identification service 3. Plant biodiversity research 4. Plant identification 5. Outreach programmes 6. Plant distribution data 		

ers. This is because of insufficient computer facilities in several of the countries that participated in SABONET. Many do not have reliable access to the Internet or e-mail. In these countries, most end-user information is required as hard copies like publications and information pamphlets. The end-users in Mozambique suggested the media (newspapers, radio, and television) as a format for providing information to raise public awareness of the role herbaria play, for example, in conservation issues. The Swaziland end-users indicated that occasional workshops and courses should be held for targeted groups of end-users.

What are the top priorities for end-users?

In many cases, the end-users in the participating countries require similar information, but their priorities vary (Table 4). The large number of taxonomists and herbarium staff in the Namibian workshop biased the top priorities of the end-users. Namibia's priorities mostly involved the development and maintenance of efficient and effectively functioning herbaria.

The top priorities of the end-users in South Africa, Mozambique, and Botswana were generally concerned with ensuring the provision of basic tasks within herbaria, for example, species lists, staff training, and relevant database information.

The top priorities of end-users in Angola, Lesotho, and Swaziland were related more to the actual products that herbaria produce, for example information on plant conservation status, medicinal plants, and Red Data Lists. Many of these end-user requirements could not be met without first dealing with the more fundamental requirements.

Future projects

Another topic that was raised at the end-user workshops was the question of whether future projects should be undertaken at regional level, in the same way as the SABONET Project, or at national level.

End-users in Angola and Lesotho preferred future projects to be on a national level.

Botswana, Mozambique, and Swaziland preferred them to be on a regional level to encourage the exchange of information between the countries. In Namibia, end-users also indicated that future projects be regional, but stipulated that these projects should be between SADC (Southern African Development Community) countries, or bilateral countries.

In South Africa, end-users indicated that future projects should

be on both a regional and national level depending on the envisioned outcome of the respective project.

Conclusions

The original questions posed to end-users of botanical information at workshops held in the SABONET countries resulted in a list of critical needs (in alphabetical order):

- Access to computerised information and products
- Efficient curation of collections
- Efficient library services and access to relevant literature
- Environmental education
- Expansion of collections
- Field guides and general information
- Improved policies, law enforcement, and sustainability
- Plant identifications
- Standardised species lists and updates of name changes
- Suitable infrastructure to house herbarium collections
- Taxonomic and related research
- Training of staff

It is evident that money is desperately needed to fulfil end-user requirements. It is necessary for the general maintenance of the buildings and for housing the collections. Funds are required to effectively curate collections and for the expansion of these collections. Training—in all aspects of herbaria activities—of both existing and new staff members, including taxonomists, technicians, and information technologists, is necessary if herbaria are to provide affordable products and services for end-users. Capital is required to produce commodities, like publishing hard copies, and developing and maintaining electronic versions of the information. The majority of the end-user requirements and priorities discussed in this report could be achieved if the relevant funding were available.

Not only financial constraints make it difficult to provide the relevant information to end-users, but also the fact that the diversity of the southern African flora is so immense that it has not been adequately studied and researched. For this reason, much of the information that is required by end-users is just not available (Steenkamp & Smith 2003).

An additional problem faced by the end-users is that the existing products and services of herbaria are not adequately advertised and publicised and the public is unaware of the existence of this information (Steenkamp & Smith 2003).

The end-user workshops have raised awareness about what the end-users of botanical information and herbaria expect. There is still a long way to go before all the information required by the end-users is available to them in the format that they require.

Other networks

This section briefly summarises some of the networks and projects that have been developed in other parts of the world, as well as their achievements. The majority of these programmes have similar aims and objectives to the SABONET project. Many of these projects are involved in capacity-building and technology development. This indicates the shortages of suitably trained staff and the lack of resources in herbaria in many developing countries.

BioNet-INTERNATIONAL

This is a global network for taxonomy that is “dedicated to creating sustainable mechanisms to overcome the ‘taxonomic impediment’ and promote self-reliance in taxonomic capacity in the developing world”. BioNet-INTERNATIONAL comprises sub-regional networks of developing country institutions or LOOPs (Locally Organised and Operated Partnerships). This results in a “south–south” relationship where taxonomic resources in developing countries can be pooled, shared, and optimised. Expert institutions in developed countries support the process, thus forming a “north–south” relationship. The effect is the transfer of information, skills, and expertise to LOOPs via donor-funded programmes. This network focuses on training, information transfer and communication, rehabilitation, establishment of biological collections and literature, development of new resources and technologies and the sustainable functioning of the LOOPs (www.bionet-intl.org).

SAFRINET is the SADC (Southern African Development Community) network of BioNet-INTERNATIONAL. It is a taxonomic capacity-building network that is concerned with living organisms, and includes identifying pollinators, species that enhance soil fertility, biological control organisms, pests, and diseases. This network covers bacteria, viruses and fungi, nematodes and other invertebrates. Some of the other LOOPs include EAFRINET, the East African network; CARINET, the Caribbean network; and EASIANET, the East Asian network (www.safirnet.ecoport.org/).

Global Taxonomy Initiative

The Global Taxonomy Initiative (GTI) was developed by the Conference of the Parties (CoP) to the Convention on Biological Diversity (CBD) because of the existing taxonomic impediment and the effect this has on the management and conservation of biodiversity. The aim of the GTI is to improve decision-making in conservation, as well as sustainable use and equitable sharing of the benefits derived from genetic resources (www.biodiv.org/programmes/cross-cutting/taxonomy/).

In 2001, the GTI Africa Regional Workshop was held in South Africa. Forty-three delegates represented 32 countries, of which 23 were African countries, and 36 institutions or organisations. The aim of the workshop was to conduct a survey of the taxonomic institutions in Africa by focusing on needs assessments, collections, projects, collaboration, staffing, teaching of taxonomy, infrastructure, inventories or floras, priority taxa, taxonomic information, and obstacles.

Institutional running costs, the lack of staff, and the lack of project-related funding for research were seen as the most im-

portant problems preventing taxonomic progress. The workshop highlighted the taxonomic impediment in Africa and the need for taxonomic capacity-building (Klopper *et al.* 2001).

BOZONET

BOZONET is the Botanical and Zoological (Taxonomic) Network for Eastern Africa. This project was developed as a result of the SABONET project in southern Africa. In Eastern Africa, the taxonomic institutions deal with both botanical and zoological issues, so a joint network was established. The objective of BOZONET is “to support the countries of East Africa to remove barriers to the flow of relevant taxonomic information, from networked centres of expertise, to the range of end-users of such information, and to assist those end-users in the use of this information for the sustainable conservation of biodiversity, through processes of inventory, description, monitoring, and dissemination”. BOZONET targets three main categories of end-users (Rodgers & Khayota 2001):

- Conservation bodies
- The commercial sector (bioprospecting, tourism, and local community sustainability)
- Traditional knowledge in local communities

The focus of the project is on conserving biodiversity and on the sustainable use of resources.

The Australian Network for Plant Conservation

The ANPC network was established to promote and develop plant conservation in Australia. There are a number of objectives, including:

- Developing a network between a range of stakeholders in plant conservation from different organisations and individuals (government, industry, and community)
- Developing and maintaining regional groups
- Promoting co-operation and information exchange
- Contributing to the recovery and long-term survival of threatened plant populations, species, communities, and ecosystems
- Coordinating and linking efforts of members and others towards plant conservation
- Lending assistance in determining the conservation status of Australia’s flora
- Recommending guidelines for best practise of conservation activities
- Obtaining, collating, and distributing information relevant to plant conservation
- Fostering communication between members through publications and meetings
- Promoting education and training strategies and programmes

Other countries have adopted a similar model, for example Canada and Indonesia. The Indonesian Network for Plant Conservation (InetPC) aims to facilitate communication and co-operation between local conservation organisations, groups, institutions, and individuals together with international representatives working on the Indonesian flora (Mill 2002). This network produces a newsletter and botanical publications, it has a membership database, a resource library, and organises conferences, seminars, and informal meetings. It promotes public awareness, networking, and

co-operative research (www.bogor.indo.net.id/inetpc).

Royal Botanic Gardens, Kew

The Royal Botanic Gardens, Kew, have a number of projects within developing countries. Planta do Nordeste (PNE) is an Anglo-Brazilian project based in the semi-arid northeastern regions of Brazil. It is a collaborative, interdisciplinary research and information dissemination programme aimed at promoting the sustainable use of plants of the region for the benefit of local communities. There are a large number of Brazilian organisations participating in the programme, including Federal and State research agencies, universities, NGOs, organisations involved in alternative agriculture, forestry, and community development. There are three aims to the programme:

- Improving the knowledge of the region's plant life and methods of sustainable management.
- Strengthening the botanical expertise, research, and management of biological data in the area through training and the exchange of staff between Brazilian and United Kingdom organisations.
- Contributing to an improved quality of life for the region's people by putting new and old knowledge into practice (www.rbgekew.org.uk/scihort/pne).

Another programme is a project in the rainforests of western Cameroon. This project is a partnership between Kew and the National Herbarium in Yaoundé that provides training for staff through workshops, and computer and e-mail access, and logistic support. There is also an association with the Botanic Gardens at Limbé, where Kew horticulturists and botanists are helping to re-develop the gardens and herbarium (www.kew.org/scihort/wta).

Kew scientists are helping local botanists in Madagascar to catalogue species and identify conservation priorities. They are involved in mapping plant distributions and compiling checklists. This project relies on funds raised by the Threatened Plants of Madagascar Appeal. The capital is used to develop skills in botanical research, plant propagation, management of plant collections, and to provide resources, for example greenhouses, pots, and plant labels (www.kew.org/friends/madagascar/).

Royal Botanic Garden Edinburgh

The Royal Botanic Garden Edinburgh has been involved in projects with local botanists in various parts of the world, for example Chile, the Peruvian Amazon, Bhutan, and Laos, to help people to conserve plant life in their own countries. This included training and educating local botanists and students in plant identification, the use of herbaria, herbarium curation, and database systems. Many of these projects have also provided student scholarships (Maspero 2003).

Missouri Botanical Garden

The Missouri Botanical Gardens are involved in projects in a number of developing countries. One of these projects, the Vietnam Botanical Conservation Programme, aims at strengthening botanical research capacity in Vietnam by improving infrastructure, training in field techniques, herbarium management, plant identifications, taxonomy, indigenous plant use, and conservation and environmental awareness. Another similar project is found in Ecuador in South America where, in collaboration with the National Herbarium, training has been done to help strengthen the technical capacity for research, management, and conservation of the natural resources (www.mobot.org/mobot/research/).



Grass identification training course.

SABONET and the Global Strategy for Plant Conservation

The Global Strategy of Plant Conservation (GSPC) was developed by the CBD. The strategy is aimed at plant conservation, but also includes other aspects, for example sustainable use, benefit-sharing, and capacity building. The aim is to achieve the 16 targets—which are grouped under five themes—by 2010 (Table 5). Although the SABONET project started before the GSPC was developed, some of the goals achieved during the Project fall under the GSPC targets.

Considerable progress has been made towards achieving Target 1 of the GSPC, which states that “a widely accessible working list of known plant species, as a step towards a complete world Flora [be developed]”. SABONET has published a number of checklists for various components of the flora in southern Africa (Table 6).

The publication of the Southern African Plant Red Data Lists, which formed part of the *SABONET Report Series*, should help to initiate Target 2, which states that “a preliminary assessment of the conservation status of all known plant species, at national, regional, and international levels [be developed]”.

During the SABONET Project, target species were selected in the participating countries for *ex situ* conservation in the Threatened Plants Programme and workshops were held on threatened plant species, which will assist with the attainment of Target 8. This target states “60 percent of threatened plant species [should be] in accessible *ex situ* collections, preferably in the country of origin, and 10 percent of them [should be] included in recovery and restoration programmes”.

The training that resulted from workshops, internships, and student sponsorships during the SABONET Project will help to achieve Target 15, which states that “the number of trained people working with appropriate facilities in plant conservation [are] increased, according to national needs, to achieve the targets of this Strategy”.

The networks that have been established through the SABONET Project will assist in achieving Target 16, which states that “networks for plant conservation activities [are] established or strengthened at national, regional, and international levels”.

Table 6: Plant inventories and checklists produced as a result of the SABONET Project.

Inventory or checklist	Authors	Publication date
A checklist of Namibian plant species	Craven	1999
Conspectus of southern African Pteridophyta	Roux	2001
A checklist of Zimbabwean grasses	Chapano	2002
A checklist of Lesotho grasses	Kobisi & Kose	2002
Trees of Botswana: names and distribution	Setshogo & Venter	2003
Swaziland ferns and fern allies	Roux	2003
Checklist of grasses in Namibia	Klaassen & Craven	2003
A checklist of Zimbabwean bryophytes	Manyanga & Perold	2004
A checklist of Botswana grasses	Kabelo & Mafokate	2004
A checklist of Zimbabwean vascular plants	Mapaura & Timberlake	In press
A preliminary checklist of the vascular plants of Mozambique	Amude, Bandeira & Izidine	In press
A checklist of Zambian vascular plants	Phiri	In press
Swaziland Flora Checklist	Braun, Dlamini, Mdladla, Methule, Dlamini & Dlamini	In press
A preliminary checklist of the vascular plants of Botswana	Setshogo	In press
Plants of the Nyika Plateau	Burrows & Willis	In press
A checklist of Angola grasses / Checklist das Poaceae de Angola	Costa, Martins & Monteiro	In press
Seed plants of southern Tropical Africa	Leistner	In press
A preliminary checklist of the plants of Lesotho	Kose	In press

Table 5: Global Strategy for Plant Conservation (GSPC) objectives and targets.

Target	Target Description
a) Understanding and documenting plant diversity	<ol style="list-style-type: none"> 1. A widely accessible working list of known plant species, as a step towards a complete world Flora. 2. A preliminary assessment of the conservation status of all known plant species, at national, regional and international levels. 3. Development of models with protocols for plant conservation and sustainable use, based on research and practical experience.
b) Conserving plant diversity	<ol style="list-style-type: none"> 4. At least 10 per cent of each of the world's ecological regions effectively conserved. 5. Protection of 50 per cent of the most important areas for plant diversity assured. 6. At least 30 per cent of production lands managed consistent with the conservation of plant diversity. 7. 60 per cent of the world's threatened species conserved in situ. 8. 60 per cent of threatened plant species in accessible ex situ collections, preferably in the country of origin, and 10 per cent of them included in recovery and restoration programmes. 9. 70 per cent of the genetic diversity of crops and other major socio-economically valuable plant species conserved, and associated indigenous and local knowledge maintained. 10. Management plans in place for at least 100 major alien species that threatened plants, plant communities and associated habitats and ecosystems.
c) Using plant diversity sustainably	<ol style="list-style-type: none"> 11. No species of wild flora endangered by international trade. 12. 30 per cent of plant-based products derived from sources that are sustainably managed. 13. The decline of plant resources, and associated indigenous and local knowledge, innovations and practices that support sustainable livelihoods, local food security and health care, halted.
d) Promoting education and awareness about plant diversity	<ol style="list-style-type: none"> 14. The importance of plant diversity and the need for its conservation incorporated into communication, educational and public-awareness programmes.
e) Building capacity for the conservation of plant diversity	<ol style="list-style-type: none"> 15. The number of trained people working with appropriate facilities in plant conservation increased, according to national needs, to achieve the targets of this Strategy. 16. Networks for plant conservation activities established or strengthened at national, regional and international levels.

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Website references

BioNet-INTERNATIONAL and SAFRINET

www.bionet-intel.org

www.safrinet.ecoport.org/

Global Taxonomy Initiative

www.biodiv.org/programmes/cross-cutting/taxonomy/

Indonesian Network for Plant Conservation

www.bogor.indo.net.id/inetpc

Royal Botanic Gardens, Kew—Planta do Nordeste

www.rbgekew.org.uk/scihort/pne

Royal Botanic Gardens, Kew—Wet Tropics Africa

www.kew.org/scihort/wta/

Royal Botanic Gardens, Kew—Threatened Plants of Madagascar Appeal

www.kew.org/friends/madagascar/

Missouri Botanical Garden

www.mobot.org/mobot/research/

Appendix 1

Questionnaire sent to the facilitators of the various end-user workshops.

National End-User Workshops

Please provide all the relevant information so that your contribution can be included in the end-user report that will form part of the SABONET Report Series.

- 1. Country:
- 2. Date of End-User Workshop:
- 3. Venue of End-User Workshop:
- 4. Facilitator of the End-User Workshop:
- 5. Presentations at the workshop (Please list the presentations that were given and who presented them):
- 6. Total number of participants at the workshop:
- 7. Please assign an end-user category to each participant. Please only assign the most appropriate category (only one) to each participant.

	Number
1. Researchers: Taxonomists Ecologists Ethnobotanists Other scientists	
2. Herbarium curators	
3. Botanic gardens / museums	
4. Government / parastatal: Ministry of Environment (or similar) Conservation bodies	
5. Educators: Tertiary (eg. universities) Secondary (eg. schools) Applied (eg. specialised training centres (forestry, agriculture))	
6. Environmental consultants	
7. Agricultural institutions / farmers	
8. International conservation Non-Government Organisations (NGOs) (eg. WWF, IUCN)	
9. National conservation NGOs (eg. wildlife societies)	
10. Traditional plant users	
11. Eco-tourism	
12. Botanical organisations (eg. botanical society)	
13. Amateur botanists	
14. Other (please provide details)	

- 8. Did the participants break up into groups to discuss the needs of the end-users? Yes / No
- 9. If yes, were the members of each group randomly selected or did the participants remain in their specific end-user category groups? Random / Specific end-user category group

10. What percentage of time of the workshop was dedicated to these discussions?

25% 50% 75% 100%

11. What would prevent you (the end-user) from using herbaria? Please prioritise each option (5 being the most important and 1 being the least important). Please mark the relevant options with an X.

	5	4	3	2	1
1. Charging of a fee					
2. The amount charged					
3. No knowledge that herbaria existed					
4. No knowledge of the services that herbaria offered					
5. Travelling distance to herbaria					
6. Insufficient collections and relevant information available at herbaria					
7. The length of time to get information back from herbaria					
8. Having no access to electronic information					
9. No quick guides for easy identification available					
10. The high quality specimens that herbaria require					

12. What would encourage you (the end-user) to use herbaria? Please prioritise each option (5 being the most important and 1 being the least important). Please mark the relevant options with an X.

	5	4	3	2	1
1. Taxonomic expertise found at herbaria					
2. Correct identifications by herbarium staff					
3. Current information (names etc.) available					
4. Access to relevant literature					
5. Easily accessible herbaria					
6. Low costs of identification					
7. Acceptable waiting periods for identification service					
8. Availability of research facilities					
9. Access to electronic products and information					
10. Relevant information on Red Data Lists, endemism, medicinal plants etc.					
11. Access to plant locality data and distribution maps					
12. The professional attitude of herbarium staff					

13. What were the main requirements of end-users of botanical information? Please rank their importance using an X for the relevant options (5 is very important and 1 is not important).

Requirements of herbaria	5	4	3	2	1
1. Species lists					
2. Plant identification					
3. Collection trips to expand plant collections					
4. Library facilities and access to relevant and latest literature					
5. Up-to-date, correct plant names					
6. Training of taxonomists / technicians					
7. Training of data-capturers					
8. Efficient curation of the collection					
9. Development of herbarium management systems					
10. Lists of endemics, medicinal plants, alien plants etc					
11. Provide information on conservation status					
12. Red Data List production					
13. Plant distribution data/maps					
14. Produce scientific publications					
15. Development of a taxonomic information system					
16. Exchange of information and loans between herbaria					
17. Outreach programme to create public awareness					
18. Provide information on plant propagation					
19. Development of new herbaria					
20. Plant ecological information, life histories etc.					
21. Plant biodiversity research					
22. Plant taxonomic research					
23. Computerised information / access to databases / web					
24. Publication of field guides, brochures and other general information					
25. Other (please specify)					

14. In what format should information be provided? Please mark with an X.

Electronic

Web / email

Publications (paper)

Other (please give details)

15. Give the 5 top overall priorities of the end-users that were determined as a result of the end-user workshop.

1.

2.

3.

4.

5.

16. Other important priorities:

17. If future projects occur, should they be undertaken at a regional or national level?
Regional / National

Thank you very much for completing this questionnaire. Your assistance is much appreciated.

Appendix 2

Appendix 2a

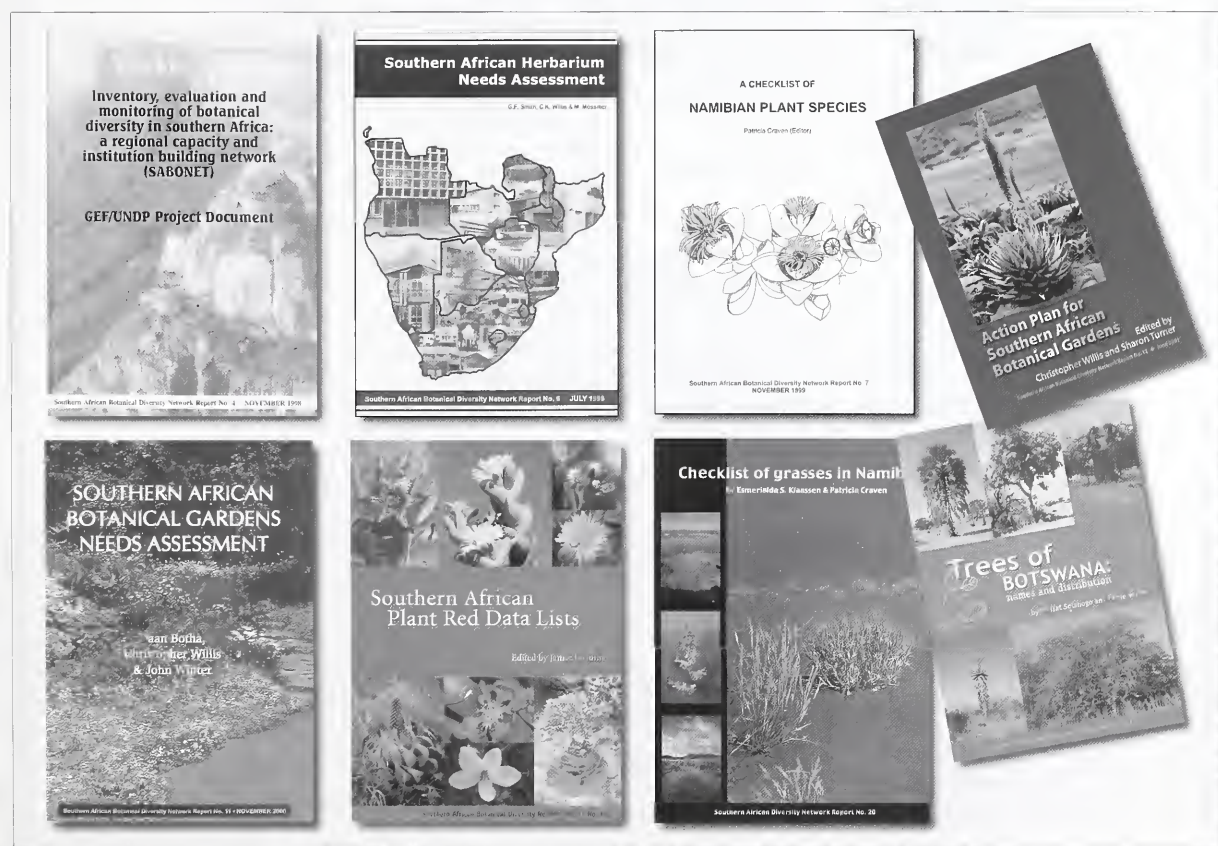
Books published in the *SABONET Report Series* to date.

1. **Southern African national herbaria: status reports, 1996.** C.K. Willis (ed.). 1997. 59 pp. ISBN 1-874907-36-6.
2. **Index herbariorum: southern African supplement.** G.F. Smith & C.K. Willis (eds). 1997. 55 pp. ISBN 1-874907-37-4.
3. **PRECIS Specimen database user guide.** C.A. Prentice & T.H. Arnold. 1998. 130 pp. ISBN 1-874907-39-0.
4. **Inventory, evaluation and monitoring of botanical diversity in southern Africa: a regional capacity and institution building network (SABONET).** B.J. Huntley, E.M. Matos, T.T. Aye, U. Nermark, C.R. Nagendran, J.H. Seyani, M.A.C. da Silva, S. Izidine, G.L. Maggs, C. Mannheimer, R. Kubirske, G.F. Smith, M. Koekemoer, G.M. Dlamini, P.S.M. Phiri, N. Nobanda & C.K. Willis. 1998. 73 pp. ISBN 1-919795-36-7.
5. **Plant taxonomic and related projects in southern Africa.** T.H. Arnold & M. Mössmer (compilers). 1998. 101 pp. ISBN 1-919795-34-0.
6. **Southern African herbarium needs assessment.** G.F. Smith, C.K. Willis & M. Mössmer. 1999. 88 pp. ISBN 1-919795-45-6.
7. **A checklist of Namibian plant species.** P. Craven (ed.). 1999. 206 pp. ISBN 1-919795-37-5.
8. **Index herbariorum: southern African supplement.** Second edition. G.F. Smith & C.K. Willis. 1999. 181 pp. ISBN 1-919795-47-2.
9. **Making your garden come alive! Environmental interpretation in botanical gardens.** M. Honig. 2000. 96 pp. ISBN 1-919795-50-2.
10. **Plant taxonomic expertise: An inventory for southern Africa.** M. Mössmer & C.K. Willis. 2000. 350 pp. ISBN 1-919795-53-7.
11. **Southern African botanical gardens needs assessment.** D.J. Botha, C.K. Willis & J.H.S. Winter. 2000. 156 pp. ISBN 1-919795-54-5.
12. **Action plan for southern African botanical gardens.** C.K. Willis & S. Turner (eds). 2001. 35 pp. ISBN 1-919795-61-8.
13. **Conspectus of southern African Pteridophyta.** J.P. Roux. 2001. 223 pp. ISBN 1-919795-58-8.
14. **Southern African plant Red Data Lists.** J.S. Golding (ed.). 2002. 256 pp. ISBN 1-919795-64-2.
15. **Addressing the needs of the users of botanical information.** Y. Steenkamp & G.F. Smith. 2002. 56 pp. ISBN 1-919795-65-0.
16. **A checklist of Zimbabwean grasses.** C. Chapano. 2002. 28 pp. ISBN 1-919795-66-9.
17. **A checklist of Lesotho grasses.** K. Kobisi & L.E. Kose. 2002. 28 pp. ISBN 1-919795-68-5.
18. **Trees of Botswana: names and distribution.** M.P. Setshogo & F. Venter. 2003. 160 pp. ISBN 1-919795-69-3.
19. **Swaziland ferns and fern allies.** J.P. Roux. 2003. 242 pp. ISBN 1-919795-97-9.
20. **Checklist of grasses in Namibia.** E.S. Klaassen & P. Craven. 2003. 130 pp. ISBN 99916-63-16-9. (Reprinted in 2004.)
21. **A checklist of Zimbabwean bryophytes.** P. Manyanga & S.M. Perold. 2004. 22 pp. ISBN 1-919976-02-7.
22. **African Botanic Gardens Congress 'Partnerships and Linkages': proceedings of a congress held at Durban Botanic Gardens, South Africa, 24–29 November 2002. / Congrès des Jardins Botaniques Africains 'Relations et Partenariats': compte rendu d'un congrès tenu dans les Jardins Botaniques de Durban, Afrique du Sud, 24–29 Novembre 2002.** C.K. Willis (ed.). 2004. 96 + 96 pp. ISBN 1-919976-04-3.
23. **Integration of Red Data List concepts into the policy framework in Mozambique: proceedings of a workshop held in Kaya-Kwanga, Maputo, Mozambique, 29–31 August 2001.** S.A. Izidine, I. Nhantumbo & J. Golding (eds). 2004. 19 + 19 pp. ISBN 1-919976-05-1.
24. **A checklist of Botswana grasses.** M. Kabelo & D. Mafokate. 2004. 18 pp. ISBN 1-919976-06-X.

Appendix 2b

Publications in the *SABONET Report Series* that are in press and will be published by the end of 2004.

25. **Herbarium essentials: the southern African herbarium user guide.** J.E. Victor, M. Koekemoer, L. Fish, S.J. Smithies & M. Mössmer. 2004.
26. **Seed plants of southern Tropical Africa.** O.A. Leistner (ed.). 2004.
27. **Swaziland Flora Checklist.** K.P. Braun, S.D.V. Dlamini, D.R. Mdladla, N.P. Methule, P.W. Dlamini & M.S. Dlamini. 2004.
28. **A checklist of Angola grasses / Checklist das Poaceae de Angola.** E. Costa, T. Martins & F. Monteiro. 2004.
30. **A preliminary checklist of the vascular plants of Mozambique.** A.B. Amude, S.O. Bandeira & S. Izidine. 2004.
31. **A checklist of Zimbabwean vascular plants.** A. Mapaura & J. Timberlake. 2004.
32. **A checklist of Zambian vascular plants.** P.S.M. Phiri. 2004.
33. **Plants of the Nyika Plateau: An account of the vegetation of the Nyika National Parks of Malawi and Zambia.** J.E. Burrows & C.K. Willis (eds). 2004.
34. **A preliminary checklist of the plants of Lesotho.** L. Kose. 2004.
35. **Ex situ conservation collection management.** M. Maunder. 2004.
36. **Growing rare plants: a propagation handbook.** G. Nichols. 2004.
37. **A preliminary checklist of the plants of Botswana.** M.P. Setshogo. 2004.
38. **A Red Data Book of Namibian plants.** S. Loots & J.E. Victor. 2004.



Appendix 3

Herbaria in the ten participating SABONET countries, together with their location and acronyms.

Country	Town/City	Herbarium	Acronym
Angola	Dundo	Herbarium, Museu do Dundo	DIA
	Huambo	Herbarium, Instituto de Investigacao Agronomica	LUA
	Luanda	Herbarium, ex-Centro Nacional de Investigacao Cientifica (CNIC)	LUAI
	Lubango	Herbario de ISCED	LUBA
Botswana	Gaborone	National Herbarium	GAB
	Gaborone	Herbarium, Department of Agricultural Research	MAH
	Gaborone	Herbarium, Department of Biological Sciences	UCBG
	Maun	Peter Smith Herbarium	PSUB
Lesotho	Maseru	Maseru Research Station Herbarium	MASE
	Roma	Herbarium, Department of Biology	ROML
	Sehlabathebe	Sehlabathebe National Park Herbarium	SNPH
Malawi	Dedza	Herbarium, Silvicultural Research Station	NYAS
	Zomba	National Herbarium and Botanic Gardens of Malawi	MAL
	Zomba	Herbarium, Department of Agriculture	ZOM
Mozambique	Maputo	Herbario, Direccao de Agricultura e Florestas	LMA
	Maputo	Herbarium, Botany Department	LMC
	Maputo	Herbario, Instituto de Investigacao Cientifica de Mozambique	LMJ
	Maputo	Herbario, Botanical Department of the Cotton Research Centre	LMU
	Maputo	Herbario, Departamento de Ciencias Biologicas	
Namibia	Windhoek	National Herbarium of Namibia	WIND
South Africa	Alice	Giffen Herbarium	UFH
	Bellville	University of the Western Cape Herbarium	UWC
	Betty's Bay	Herbarium, Harold Porter National Botanical Garden	GHPG
	Bloemfontein	Geo-Potts Herbarium	BLFU
	Bloemfontein	Free State National Botanical Garden Herbarium	GOFS
	Bloemfontein	National Museum Herbarium	NMB
	Cape Town	Bolus Herbarium	BOL
	Cape Town	Cape Technikon Herbarium	Cape Technikon
	Cape Town	Crompton Herbarium	NBG and SAM
	Cedara	Herbarium, Cedara Agricultural College	Cedara Agricultural College
	Citrusdal	Cederberg Wilderness Field Herbarium	Cederberg Wilderness
	Durban	Natal Herbarium	NH
	Durban	Ward Herbarium	UDW
	Durban	Herbarium, University of Natal Durban	UNDH
	Empangeni	Herbarium, University of Zululand	ZULU
	George	Herbarium, Faculty of Forestry, Saasveld	SAAS
	George	Southern Cape Herbarium	SCHG
	Graaff-Reinet	Karoo Nature Reserve Herbarium	Karoo Nature Reserve
	Grahamstown	Selmar Schonland Herbarium	GRA
	Grahamstown	Great Fish River Reserve Herbarium	Great Fish River Reserve

Country	Town/City	Herbarium	Acronym
South Africa	Harrismith	Sterkfontein Dam Nature Reserve Herbarium	Sterkfontein Dam Nature Reserve
	Heidelberg	Herbarium, Suikerbosrand Nature Reserve	Suikerbosrand Nature Reserve
	Hermanus	Hermanus Botanical Society Herbarium	HER
	Johannesburg	Charles E. Moss Herbarium	J
	Johannesburg	Herbarium, Johannesburg Botanic Gardens	JBG
	Johannesburg	Herbarium, Rand Afrikaans University	JRAU
	Kimberley	McGregor Museum Herbarium	KMG
	Kimberley	Kimberley SANParks Herbarium	KSAN
	Knysna	Herbarium of the Scientific Services Division	Department of Water Affairs and Forestry
	Knysna	Herbarium of the Goukamma Nature Reserve	Goukamma Nature Reserve
	Luckoff	Rolfontein Nature Reserve Herbarium	Rolfontein Nature Reserve
	Lydenburg	Mpumalanga Parks Board Herbarium	LYD
	Lydenburg	Buffelskloof Herbarium	Buffelskloof Private Nature Reserve
	Mara	Mara Agricultural Development Centre Herbarium	Mara Agricultural Development Centre
	Middelburg	Herbarium, Grootfontein Agricultural Development Institute	Grootfontein Agricultural College
	Mmabatho	Herbarium, University of North-West	UNWH
	Nelspruit	Herbarium, Lowveld National Botanical Gardens	GLOW
	Oudtshoorn	Herbarium of the Gamkaberg Nature Reserve	Gamkaberg Nature Reserve
	Phuthaditjhaba	Uniqwa Herbarium	QWA
	Pietermaritzburg	Donald Killick Herbarium	CPF
	Pietermaritzburg	Bews Herbarium	NU
	Pietersburg	Herbarium, University of the North	UNIN
	Pilanesberg	Herbarium, Pilanesburg National Park	Pilanesburg National Park
	Port Edward	Umtamvuna Nature Reserve	Umtamvuna Nature Reserve
	Port Elizabeth	F.R. Long Herbarium	MPE
	Port Elizabeth	Ria Olivier Herbarium	PEU
	Potchefstroom	A.P. Goossens Herbarium	PUC
	Pretoria	National Herbarium	PRE
	Pretoria	National Collection of Fungi	PREM
	Pretoria	H.G.W.J. Schweickerdt Herbarium	PRU
	Pretoria	Herbarium, ARC-Range and Forage Institute	ROO
	Pretoria	Technikon Pretoria Herbarium	Technikon Herbarium
	Robertson	Vrolijkheid Nature Reserve Herbarium	Vrolijkheid Nature Reserve
	Rustenburg	Herbarium, Rustenburg Nature Reserve	Rustenburg Nature Reserve
	Sedgefield	Herbarium of Rondevlei Scientific Services	Wilderness National Park
	Skukuza	Skukuza Herbarium	KNP
	Somerset West	Helderberg Nature Reserve Herbarium	Helderberg Nature Reserve
	Soutpansberg	Herbarium Soutpansbergensis	Herbarium Soutpansbergensis
	Springbok	Goegap Nature Reserve Herbarium	Goegap Nature Reserve
	Stellenbosch	Fungal Culture Collection, University of Stellenbosch	Fungal Culture Collection
	Stellenbosch	Williams Herbarium	FFS
	Stellenbosch	Jonkershoek Herbarium	JONK
	Stellenbosch	Herbarium, University of Stellenbosch	STEU
	Stutterheim	Dohne Agricultural Development Institute Herbarium	Dohne Agricultural Development Institute
	Stutterheim	Isidenge Herbarium	Isidenge State Forest
	Thohoyandou	Venda Herbarium	VENDA
	Thornhill	Van Stadens Nature Reserve Herbarium	Van Stadens Nature Reserve

Country	Town/City	Herbarium	Acronym
South Africa	Uitenhage	Weeds Herbarium	
	Umtata	Herbarium, University of Transkei	KEI
	Venterstad	Oviston Nature Reserve Herbarium	Oviston Nature Reserve
	Warmbaths	Towoomba Agricultural Development Centre Herbarium	Towoomba Agricultural Development Centre
	Worcester	Field Reserve Herbarium	Worcester Field Reserve
	Worcester	Karoo National Botanical Garden Herbarium	GKAR
Swaziland	Manzini	National Herbarium of Swaziland	SDNH
Zambia	Chilanga	Mount Makulu Herbarium	MRSC
	Kitwe	Herbarium, Division of Forest Research	NDO
	Lusaka	Herbarium, Department of Biological Sciences	UZL
	Mbala	Herbarium, International Red Locust Control Organisation	LCO & LCS
	Mfuwe	Chinzombo Herbarium	MFUW
Zimbabwe	Bulawayo	The Botanical Collection, Natural History Museum of Zimbabwe	BUL
	Harare	Herbarium, Department of Biological Sciences	CAH
	Harare	National Herbarium and Botanic Garden	SRGH
	MatoposMutare	Herbarium, Matopos Research StationChase Herbarium	MRSHUMT

Appendix 4

List of potential end-users of botanical information. This list was compiled from Steenkamp & Smith (2002) and Morin, Whetstone, Wilken & Tomlinson (1988). Many of these examples of potential end-users were discussed and determined during a workshop held in Virginia on "Floristics for the 21st Century" (Morin *et al.* 1988) and are therefore more relevant to the northern hemisphere.

Ecological/environmental consultants
Vegetation surveyors
Rehabilitation specialists
Forest managers
Environmental engineers
Mining engineers
Civil engineers
Farmers
Agricultural consultants
Extension agents
Environmental lawyers
Custom, border and airport officials
Postal services
Health and food industry
Food quality controllers
Animal feed companies
Forensic scientists
Medical examiners
Dermatologists
Traditional plant users
Silviculturists
Rare and endangered species agents
Fertilizer manufacturers
Plant breeders

Seed laboratories
Seed companies
Nurserymen
Poison control centres
Plant pathologists
Landscape architects
Interior designers
Architects
Real estate appraisers
Land use managers
Municipal and regional planners
Weed and pest controllers
Recreation managers and planners
Sports field and green keepers
Right-of-way engineers
Flood control engineers
Waterway managers
Toxicologists
Outdoor enthusiasts
Illustrators
Users of natural dyes, craftspeople
Teachers
Adult Educators



Botanical garden management course — inside a nursery.

Appendix 5

Consolidated list of products required by the end-users of information generated by herbaria participating in the SABONET Project.

Species lists	Up-to-date, correct plant names
Plant identification	Plant biodiversity research
Collection trips to expand collections	Plant taxonomic research
Library facilities and access to relevant and latest literature	Training of taxonomists/technicians
Training of data-capturers	Computerised information/access to databases/web
Efficient curation of the collections	Publication of field guides, brochures, and other general information
Development of Herbarium Management Systems	Help desk on botanical information
Lists of endemics, medicinal plants, alien plants, etc.	Signage in herbaria and botanical gardens
Provide information on plant conservation status	State of environmental report
Red Data List production	Infrastructure and space
Plant distribution data/maps	Policies
Produce scientific publications	Translation of existing literature
Development of a Taxonomic Information System	Botanical Information System
Exchange of information and loans between herbaria	Training of users of botanical information
Outreach programme to create public awareness of herbaria	Consolidation of taxonomic services
Provide information on plant propagation	Enforcement of flora protection laws
Development of new herbaria	
Plant ecological information, life histories, etc.	



Herbarium Management training course – Preparing herbarium specimens.

Appendix 6

Appendix 6a

Results from the questionnaire sent out to the participating countries to determine what would deter end-users from using herbaria. ▲—very important, ■—intermediate, ●—not important. No information was supplied for Malawi, Zambia, and Zimbabwe.

	Angola	Botswana	Lesotho	Malawi	Mozambique	Namibia	South Africa	Swaziland	Zambia	Zimbabwe
Charging a fee		▲	●		●	●	▲	■		
The amount charged		▲	●		●	■	▲	●		
No knowledge that the herbaria existed	▲	▲	▲		■	●	●	▲		
No knowledge of the services that the herbaria offered	▲	▲	▲		▲	▲	▲	▲		
Travelling distance to herbaria	●	■	■		▲	●	■	■		
Insufficient collections and relevant information available at herbaria	■	■	●		▲	●	■	▲		
The length of time to get information back from herbaria	▲	▲	●		▲	▲	▲	▲		
Having no access to electronic information	■	●	▲		▲	■	■	■		
No quick guides for easy identification available	■	■	▲		▲	■	●	▲		
The high quality of specimens that herbaria require	●	●	▲		▲	●	▲	▲		

Appendix 6b

Results from the questionnaire sent out to the participating countries to determine what would encourage end-users to use herbaria. ▲—very important, ■—intermediate, ●—not important. No information was supplied for Malawi, Zambia, and Zimbabwe.

	Angola	Botswana	Lesotho	Malawi	Mozambique	Namibia	South Africa	Swaziland	Zambia	Zimbabwe
Taxonomic expertise found at herbaria	▲	▲	▲		▲	▲	▲	▲		
Correct identifications by herbarium staff	■	▲	▲		▲	▲	▲	▲		
Current information (names etc.) available	■	▲	▲		▲	▲	▲	■		
Access to relevant literature	■	▲	▲		■	■	▲	▲		
Easily accessible herbaria	▲	▲	▲		▲	●	■	■		
Low costs of identification	▲	▲	▲		▲	▲	▲	■		
Acceptable waiting periods for identification service	▲	▲	▲		▲	▲	▲	▲		
Availability of research facilities	▲	▲	▲		▲	●	▲	▲		
Access to electronic products and information	■	●	▲		●	▲	▲	▲		
Relevant information on Red Data Lists/endemism/medicinal plants	■	▲	▲		▲	▲	▲	▲		
Access to plant locality data and distribution maps	■	▲	▲		●	▲	▲	▲		
The professional attitude of herbarium staff	▲	▲	▲		▲	■	▲	▲		

Appendix 6c

Results from the questionnaire sent out to the participating countries to determine what the end-users of botanical information require from herbaria. ▲—very important, ■—intermediate, ●—not important. No information was supplied for Malawi, Zambia, and Zimbabwe.

	Angola	Botswana	Lesotho	Malawi	Mozambique	Namibia	South Africa	Swaziland	Zambia	Zimbabwe
Species list	▲	▲	▲		▲	▲	▲	▲		
Plant identification	▲	▲	▲		▲	▲	▲	▲		
Collection trips to expand collections	■	▲	▲		▲	●	▲	▲		
Library facilities and access to relevant and latest literature	■	▲	▲		▲	▲	■	▲		
Up-to-date, correct plant names	■	▲	▲		▲	▲	▲	▲		
Training of taxonomists/technicians	▲	▲	▲		▲	▲	■	■		
Training of data-capturers	▲	■	▲		▲	●	■	■		
Efficient curation of the collection	■	▲	▲		▲	▲	■	▲		
Development of Herbarium Management Systems	■	▲	▲		▲	●	■	■		
Lists of endemics, medicinal plants, alien plants etc.	■	▲	▲		▲	■	▲	▲		
Provide information on plant conservation status	●	▲	▲		▲	●	▲	▲		
Red Data List production	▲	▲	▲		▲	●	▲	▲		
Plant distribution data/maps	■	▲	▲		▲	■	▲	▲		
Produce scientific publications	▲	▲	▲		▲	■	▲	■		
Development of a Taxonomic Information System	▲	▲	▲		▲	▲	▲	■		
Exchange of information and loans between herbaria	●	▲	▲		▲	■	■	■		
Outreach programme to create public awareness of herbaria	■	▲	▲		▲	■	■	▲		
Provide information on plant propagation	●	■	▲		▲	●	●	▲		
Development of new herbaria	▲	■	▲		▲	●	●	▲		
Plant ecological information, life histories etc.	●	▲	▲		▲	■	▲	■		
Plant biodiversity research	■	▲	▲		▲	●	▲	▲		
Plant taxonomic research	■	▲	▲		▲	■	▲	▲		
Computerised information/access to databases/web	▲	▲	▲		▲	▲	▲	▲		
Publication of field guides, brochures and other general information	▲	▲	▲		▲	■	▲	▲		
Other*		▲	▲			▲■		▲		

* Botswana (help desk on botanical information, signage); Lesotho (state of environmental report); Namibia (infrastructure/space, policies, translation, Botanical Information System, training of users, consolidation of taxonomic services); Swaziland (enforcement of flora protection laws)

About SABONET

This publication is a product of the Southern African Botanical Diversity Network (SABONET), a programme aimed at strengthening the level of botanical expertise, expanding and improving herbarium and botanic garden collections, and fostering closer collaborative links among botanists in the southern African subcontinent.

The main objective of SABONET is to develop a strong core of professional botanists, taxonomists, horticulturists, and plant diversity specialists within the ten countries of southern Africa (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe). This core group will be competent to inventory, monitor, evaluate, and conserve the botanical diversity of the region in the face of specific development challenges, and to respond to the technical and scientific needs of the Convention on Biological Diversity.

To enhance the human resource capacity and infrastructure available in the region, SABONET offers training courses, workshops, and collaborative expeditions in under-collected areas. The programme produces a series of occasional publications, the Southern African Botanical Diversity Network Report Series, and a newsletter, SABONET News.

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- The Global Environment Facility (GEF)/United Nations Development Programme (UNDP)

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